84

DRAFT REPORT
December 8, 1992

MADISON COUNTY
GRANITE CITY, ILLINOIS
LEAD EXPOSURE STUDY

Illinois Department of Public Health

Springfield, Illinois

Institute for Evaluating Health Risks

Washington, DC

Agency for Toxic Substances and Disease Registry

Public Health Service,

U.S. Department of Health and Human Services

Atlanta, GA

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DISCLAIMER?

SUMMARY

A lead exposure study of 827 participants was conducted around a defunct secondary lead smelter. The arithmetic mean venous blood lead level in 490 children under age 6 was 0.33 µmol/L (6.9 µg/dl), with a range of 0.03-1.94 µmol/L (0.7-40.2 µg/dl). The blood lead levels of 78 children in this group were 0.48 µmol/L (10 µg/dl) or higher. Of the 78 children under 6 with blood lead levels above 0.48 µmol/L (10 µg/dl), only 5 children had a blood lead level above 1.21 µmol/L (25 µg/dl). Blood lead levels in 214 youths between 6 and 15 years of age were lower with a mean of 0.33 µmol/L (4.4 µg/dl) and a range of < 0.03-0.90 µmol/L (< 0.6-18.8 µg/dl). Only 8 children in this group had blood lead levels above 0.48 µmol/L (10 µg/dl). Mean blood lead levels in adults were 0.17 µmol/L (3.6 µg/dl) and in 14 pregnant women 0.08 µmol/L (1.6 µg/dl). The mean blood lead levels in ~~this group of~~ the study participants were lower than levels reported in the United States 15 to 20 years ago, when lead levels in air and lead in food were higher. No recent national data are available for comparison.

WOULD NEED TO KEEP THIS ONE

Blood lead regression

The condition of the houses, and the amount of lead in paint and soil was positively correlated with blood lead levels in children. Regression analysis showed that lead in paint alone accounted for 3% of the variance in children's blood lead level. Lead in paint and the condition of the houses together accounted

NOT A BIG CONTRIBUTION!

for 11% of the variance in blood lead. Adding soil lead to the regression equation for lead in paint and condition of the houses accounted for an additional 3% of the variance in blood lead raising the total variance accounted for to $R^2=0.13$; thus, the condition of the houses was a more important factor in predicting children's blood lead levels than either paint or soil lead.

The analyses also showed that only 40% of the variance in blood lead could be accounted for by including all of the variables in the study. The remainder of the variance apparently depended on individual behavior and activities of the different families. Blood lead levels in children were significantly associated with environmental, socioeconomic, and behavioral factors. However, these associations were weak and intercorrelated.

Dust lead regression

The best single predictor of blood lead, and the major pathway of exposure for children under the age of six, was lead in house dust. Lead from paint and lead from soil contributes to the lead in house dust, so including all three factors in the same regression equation over adjusts (i.e., erroneously diminishes) the contribution of house dust to children's blood lead levels. Based on the regression analyses, lead from paint alone accounted for 11% of the variance in house dust lead. When both the condition of the houses and the level of lead in the paint were considered together, the amount of variance that was accounted for more than doubled, increasing to 16%. Adding soil

11×2=16?

lead to the regression equation for paint lead and building condition increased the amount of variance accounted for by an additional 6%, raising the total house dust lead variance accounted for by all three factors to R^2=0.32. Thus, paint lead and building condition together are more than four times as important as lead from soil as contributors to house dust lead.

Many houses (—%) in this community were built before 1920 and had elevated lead paint levels. Some of the older houses were in poor condition, with peeling and chipping paint. Elevated levels of lead were found in the soil surrounding many of the houses. Blood lead levels in children tended to go up as the condition of the house they lived in, and their parents' education and income level, went down. Education was a better predictor of blood lead levels than income. The condition of the houses, and the education and income level of parents, also tended to go down as soil lead levels went up.

The blood lead levels also tended to be higher in the children who lived in houses that had recently undergone repair or renovation.

Drinking water was only a very minor contributor to exposure. Lead in drinking water was below the limit of detection of 2 μg/L (ppb) in 62% of the samples taken at the tap.

ANY STUDY LIMITATIONS

HEAVY METAL EXPOSURE ASSESSMENT QUESTIONNAIRE

PARTICIPANT NAME ______________________________

PARTICIPANT ID NUMBER ___ ___ ___ ___ - ___ ___ ___ ___

HOUSE ID NUMBER ___ ___ ___ ___

Street Address:

Street ______________________________ Apt.________

City ______________________________ State____________

Zip code ________________

Mailing Address:

Street ______________________________ Apt.________

City ______________________________ State____________

Zip code ________________

Telephone number:

home (__ __ __) ___ ___ ___ - ___ ___ ___ ___

work (__ __ __) ___ ___ ___ - ___ ___ ___ ___

1 = Phone
2 = No phone
8 = REFUSED
9 = DON'T KNOW

(001-004) HOUSE ID __ __ __ __

(005-010) DATE __ __/__ __/__ __

100 HOUSEHOLD QUESTIONNAIRE

THE FOLLOWING QUESTIONS MUST BE ANSWERED BY PARENT OR LEGAL GUARDIAN IF THE SUBJECT IS AGED 14 OR YOUNGER.

First, I would like to ask you some questions about the home you/SUBJECT lives in. (WHERE SUBJECT LIVES MOST OF THE TIME IN THE LAST 90 DAYS)

(Circle applicable answer.)

(011-012) 101. What year was this house built? (OLDEST PART)

- 00 = <1900-1909
- 01 = 1910-1919
- 02 = 1920-1929
- 03 = 1930-1939
- 04 = 1940-1949
- 05 = 1950-1959
- 06 = 1960-1969
- 07 = 1970-1979
- 08 = 1980-1989
- 09 = 1990-present
- 99 = DON'T KNOW

(013) 102. What type of exterior does your/SUBJECT'S home have?

- 1 = wood
- 2 = brick
- 3 = block
- 4 = mobile home
- 5 = vinyl/metal siding
- 6 = Other ______________________
- 9 = DON'T KNOW

(014) 103. Is the home you/SUBJECT live in rented or owned?

- 1 = rent
- 2 = own
- 3 = other ______________________
- 8 = REFUSED
- 9 = DON'T KNOW

(015) 104. What type of water pipes does the home contain?

- 1 = lead
- 2 = plastic
- 3 = galvanized steel
- 4 = copper
- 5 = iron
- 6 = mixed (specify) ______________________
- 7 = Other (specify) ______________________
- 9 = DON'T KNOW

105. What type of water does your/SUBJECT'S household normally use most for:

	Drinking (016)	Cooking (017)
Private well water	1	1
Public water (city or district)	2	2
Bottled	3	3
Local spring or brook	4	4
Cistern	5	5
Other ________________	6	6
DON'T KNOW	9	9

106. Which fuel do you use most for: (Circle one per column)

	House Heating (018)	Water Heating (019)	Cooking (020)
Gas--bottled or tank	1	1	1
Gas--pipes (natural gas)	2	2	2
Electricity	3	3	3
Fuel oil or kerosene	4	4	4
Coal or coke	5	5	5
Wood	6	6	6
Other ________________	7	7	7
DON'T KNOW	9	9	9

107. Has any part of your house been repainted, sanded, or chemically or heat stripped, or otherwise refinished within the last year?

(021)
1 = Yes
2 = No
9 = DON'T KNOW

IF YES, Approximately when was this most recently done?

(022-025) ___ ___ / ___ ___ (MONTH / YEAR) (ENTER 99 IF DON'T KNOW MONTH)

108. Do you use air conditioning in your/SUBJECT'S home?

(026)
1 = Yes
2 = No
9 = DON'T KNOW

HOUSEHOLD ACTIVITIES/OCCUPATIONS

Now I'd like to ask you some questions about the work and hobbies of all persons living in this home. (ALL household members included)

(027) 109. Have any members of the household worked in mining or a mining related job such as mine material handling or transportation in the last 90 days?

1 = Yes
2 = No (GO TO 114)
9 = DON'T KNOW (GO TO 114)

110. What type of mining or mine related work have household members done in the last 90 days? (Circle all that apply.)

			Yes	No	Don't know
(028)	a.	Underground	1	2	9
(029)	b.	Surface	1	2	9
(030)	c.	Milling	1	2	9
(031)	d.	Transportation/ handling	1	2	9
(031)	e.	Clerical/Admin.	1	2	9
(032)	f.	Smelter	1	2	9
(033)	g.	Other	1	2	9

IF OTHER, SPECIFY: ____________________

111. What type of mine or mine materials have household members worked with in the last 90 days? (Circle all that apply.)

			Yes	No	Don't know
(034)	a.	Lead	1	2	9
(035)	b.	Zinc	1	2	9
(036)	c.	Silver	1	2	9
(037)	d.	Molybdenum	1	2	9
(038)	e.	Coal	1	2	9
(039)	f.	Limestone	1	2	9
(040)	g.	Clay	1	2	9
(041)	h.	Other	1	2	9

IF OTHER, SPECIFY: ____________________

112. Does any household member(s) that works in a mine or mining related job wear HIS/HER work clothing home after working?

(042)
1 = Always
2 = Sometimes
3 = Never
9 = DON'T KNOW

113. Does any household member(s) that works in a mine or mining related job come home from work without showering?

(043)
1 = Always
2 = Sometimes
3 = Never
9 = DON'T KNOW

Next I have s[illegible] questions about a number of activities you or other household members may do or may have done in the last three months. These include things you may have done for work, hobbies, or chores and at home or other places.

114. In the last 90 days, have any members of your household:
(Circle all that apply)

114a. Was this done at home, work, or elsewhere?

114B. IF WORK/OTHER: Were those clothes worn home? / Did he/she shower before coming home?

114.	Yes	No	Don't know	114a. HOME OTHER	WORK/	BOTH	Don't know	114B. Clothes worn home? Yes	No	Don't know	Shower before coming home? Yes	No	Don't know
a. Painted pictures with artists paints? (not children's paints)	1	2 (044)	9	3	4 (045)	5	9	1	2 (046)	9	1	2 (047)	9
b. Painted, stained or refinished furniture?	1	2 (048)	9	3	4 (049)	5	9	1	2 (050)	9	1	2 (051)	9
c. Painted the inside or outside of a home or building?	1	2 (052)	9	3	4 (053)	5	9	1	2 (054)	9	1	2 (055)	9
d. Work with stained glass?	1	2 (056)	9	3	4 (057)	5	9	1	2 (058)	9	1	2 (059)	9
e. Cast lead into fishing sinkers, bullets or anything else?	1	2 (060)	9	3	4 (061)	5	9	1	2 (062)	9	1	2 (063)	9
f. Worked with soldering in electronics?	1	2 (064)	9	3	4 (065)	5	9	1	2 (066)	9	1	2 (067)	9
g. Soldering pipes or sheets of metal?	1	2 (068)	9	3	4 (069)	5	9	1	2 (070)	9	1	2 (071)	9
h. Repaired auto radiators?	1	2 (072)	9	3	4 (073)	5	9	1	2 (074)	9	1	2 (075)	9

114. (Continued)
In the last 90 days, have any members of your household:
(Circle all that apply)

114a. Was this done at home, work, or elsewhere?

114B. IF WORK/OTHER: Were those clothes worn home? Did he/she shower before coming home?

	Yes	No	Don't know	HOME	WORK/ OTHER	BOTH	Don't know	Clothes worn home? Yes	No	Don't know	Shower? Yes	No	Don't know
i. Worked on auto bodies or auto maintenance? (includes mechanics)	1	2 (076)	9	3	4 (077)	5	9	1	2 (078)	9	1	2 (079)	9
j. Worked at a sewage treatment plant?	1	2 (080)	9	3	4 (081)	5	9	1	2 (082)	9	1	2 (083)	9
k. Made pottery?	1	2 (084)	9	3	4 (085)	5	9	1	2 (086)	9	1	2 (087)	9
l. Ridden a dirt bike, mountain bike or ATV in the local area?	1	2 (088)	9	3	4 (089)	5	9	1	2 (090)	9	1	2 (091)	9
m. Welding?	1	2 (092)	9	3	4 (093)	5	9	1	2 (094)	9	1	2 (095)	9
n. Cleaned or repaired firearms?	1	2 (096)	9	3	4 (097)	5	9	1	2 (098)	9	1	2 (099)	9
o. Visited indoor firearm target ranges?	1	2 (100)	9	3	4 (101)	5	9	1	2 (102)	9	1	2 (103)	9
p. Wire/cable cutting or splicing?	1	2 (104)	9	3	4 (105)	5	9	1	2 (106)	9	1	2 (107)	9
q. Casting or smelting lead?	1	2 (108)	9	3	4 (109)	5	9	1	2 (110)	9	1	2 (111)	9

114. (Continued)
In the last 90 days, have any members of your household:
(Circle all that apply)

114a. Was this done at home, work, or elsewhere?

114B. IF WORK/OTHER: Were those clothes worn home? Did he/she shower before coming home?

	Yes	No	Don't know	HOME OTHER	WORK/	BOTH	Don't know	Yes	No	Don't know	Yes	No	Don't know
r. Plastics manufacture?	1	2 (112)	9	3	4 (113)	5	9	1	2 (114)	9	1	2 (115)	9
s. Battery manufacture?	1	2 (116)	9	3	4 (117)	5	9	1	2 (118)	9	1	2 (119)	9
t. Pipe machining?	1	2 (120)	9	3	4 (121)	5	9	1	2 (122)	9	1	2 (123)	9
u. Electroplating with lead solutions?	1	2 (124)	9	3	4 (125)	5	9	1	2 (126)	9	1	2 (127)	9
v. Refining gasoline?	1	2 (128)	9	3	4 (129)	5	9	1	2 (130)	9	1	2 (131)	9
w. Paint, glaze, and ink manufacture?	1	2 (132)	9	3	4 (133)	5	9	1	2 (134)	9	1	2 (135)	9
x. Rubber manufacture?	1	2 (136)	9	3	4 (137)	5	9	1	2 (138)	9	1	2 (139)	9
y. Scrap metal recovery?	1	2 (140)	9	3	4 (141)	5	9	1	2 (142)	9	1	2 (143)	9
z1. Other lead related job or activity? SPECIFY________________	1	2 (144)	9	3	4 (145)	5	9	1	2 (146)	9	1	2 (147)	9
z2. Other cadmium related job or activity? SPECIFY________________	1	2 (148)	9	3	4 (149)	5	9	1	2 (150)	9	1	2 (151)	9

Now I'd like to ask you some questions about your diet and food preparation:

115. When food or drinks are prepared, served, or stored, are they often placed in clay pottery or ceramic dishes which were homemade or made in another country?

(152)

1 = Yes
2 = No
9 = DON'T KNOW

116. When food or drinks are prepared, served, or stored, are they often placed in copper or pewter dishes or containers?

(153)

1 = Yes
2 = No
9 = DON'T KNOW

117. When food or drinks are stored or put away, are they sometimes stored in the original can after being opened?

(154)

1 = Yes
2 = No
9 = DON'T KNOW

Now I have a few other questions about your household.

118. Does anyone smoke in your/SUBJECT'S home?

(155) 1 = Yes
2 = No (GO TO 121)
9 = DON'T KNOW

119. How many people smoke in this home? (including regular visitors/babysitters)

(156-157) __ __ (number of people)
(99 = DON'T KNOW)

120. Does anyone smoke TOBACCO PRODUCT in your/SUBJECT's home?

(Circle responses).

		Yes	No	Don't know	IF YES, How many:
(158)	a.Cigarettes	1	2	9	(159-160) __ __Cigarettes per day in the house? (1 pack=20)
(161)	b.Cigars	1	2	9	(162-163) __ __Cigars per day in the house?
(164)	c.Pipes	1	2	9	(165-166) __ __Pipe bowls per day in the house?

121. Do you have any dogs or cats that go in and out of the house?

(167) 1 = Yes
2 = No
9 = DON'T KNOW

If yes, specify number ____________

122. Has anyone ever used any materials from mines or smelters, such as chat or slag, or lead industry material in or around your house or yard?

(168) 1 = Yes
2 = No
9 = DON'T KNOW

IF YES, SPECIFY WHAT MATERIALS AND HOW THEY WERE USED:

____

____

(169-171) 123. What is the highest year of education that was completed by the head of this household? (RESPONDENT MUST DECIDE WHO HEAD OF HOUSEHOLD IS)

(circle one)

No Schooling	000
Elementary School	001 002 003 004 005 006 007 008
High School (GED=012)	009 010 011 012
Technical or Trade School	T13 T14
Junior or Community College	J13 J14
Four year College or University	013 014 015 016
Attended Graduate School (or higher)	017
REFUSED TO ANSWER	088
DON'T KNOW	099

(172) 124. **What is your total, gross household income before taxes?**

01 =$4,999 or less	07 =$30,000 to $34,999
02 =$5,000 to $9,999	08 =$35,000 to $39,999
03 =$10,000 to $14,999	09 =$40,000 or more
04 =$15,000 to $19,999	88 = REFUSED TO ANSWER
05 =$20,000 to $24,999	99 = DON'T KNOW
06 =$25,000 to $29,999	

Now we have a set of questions to ask about (SUBJECT'S NAME)

IF PARTICIPANT IS 6 - 71 MONTHS OF AGE, THEN GO TO SECTION 200.

IF PARTICIPANT IS 6 - 14 YEARS OF AGE, GO TO SECTION 300

IF PARTICIPANT IS 15 YEARS OF AGE OR OLDER, GO TO SECTION 400

200 CHILD QUESTIONNAIRE
AGE 6 - 71 MONTHS

HOUSE ID ___ ___ ___ ___

PERSON ID ___ ___ ___ ___ - ___ ___ ___ ___

QUESTIONS ABOUT THE CHILD 6 - 71 MONTHS OLD (LESS THAN 6 YEARS OLD) SHOULD BE ANSWERED BY THE PARENT OR LEGAL GUARDIAN OF THE CHILD.

Child's full legal name:____

IF CHILD LESS THAN 3 YEARS OLD:

(027) 207. Does this child breast feed?

1 = Yes
2 = No
7 = Not applicable, over 3 years old
8 = REFUSED
9 = DON'T KNOW

208. In the last 90 days, where does (CHILD'S NAME) usually spend HIS/HER time each 24 hour period? (approximate number of hours)
(99 = DON'T KNOW)

	Babysitter (outside of home)	Day Care (commercial facility)	Other Location	Home	Total (24 hrs)
Monday	(028-029)	(030-031)	(032-033)	(034-035)	(036-037)
Tuesday	(038-039)	(040-041)	(042-043)	(044-045)	(046-047)
Wednesday	(048-049)	(050-051)	(052-053)	(054-055)	(056-057)
Thursday	(058-059)	(060-061)	(062-063)	(064-065)	(066-067)
Friday	(068-069)	(070-071)	(072-073)	(074-075)	(076-077)
Saturday	(078-079)	(080-081)	(082-083)	(084-085)	(086-087)
Sunday	(088-089)	(090-091)	(092-093)	(094-095)	(096-097)

209. How many hours, on average, does CHILD spend sleeping?

(098-099) ___ ___ (99 = DON'T KNOW)

210. How many hours during the day do you think (CHILD'S NAME) usually spends playing on the floor when indoors in this home?

(100-101) ___ ___ Hours (99 = DON'T KNOW)

217. Are (CHILD'S NAME) hands or face usually washed before eating?
(110)
1 = Yes
2 = No
9 = DON'T KNOW

218. Are (CHILD'S NAME) hands or face usually washed before going to sleep?
(111)
1 = Yes
2 = No
9 = DON'T KNOW

219. Are (CHILD'S NAME) hands or face usually washed after playing with dirt or sand?
(112)
1 = Yes
2 = No
9 = DON'T KNOW

220. How many times is (CHILD'S NAME) bathed or given a shower?

(113-114) ___ ___ per week (99 = DON'T KNOW)

221. Has (CHILD'S NAME) used a pacifier in the last 6 months?
(115)
1 = Yes
2 = No
9 = DON'T KNOW

222. Does (CHILD'S NAME) suck HIS/HER thumb or fingers?
(116)
1 = Yes
2 = No
9 = DON'T KNOW

223. Does (CHILD'S NAME) chew on HIS/HER fingernails?
(117)
1 = Yes
2 = No
9 = DON'T KNOW

224. Does (CHILD'S NAME) have a favorite blanket or toy?
(118)
1 = Yes
2 = No (GO TO QUESTION 227)
9 = DON'T KNOW

225. Does (CHILD'S NAME) carry this around during the day?
(119)
1 = Yes
2 = No
9 = DON'T KNOW

226. Does (CHILD'S NAME) often put this in HIS/HER mouth?
(120)
1 = Yes
2 = No
9 = DON'T KNOW

233. How often does (CHILD'S NAME) eat vegetables grown in your garden?

(127)
1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 236)
9 = DON'T KNOW (GO TO 236)

234. How often does (CHILD'S NAME) eat leafy green vegetables, (such as lettuce or spinach) grown in your garden?

(128)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

235. How often does (CHILD'S NAME) eat root vegetables, (such as beets or turnips) grown in your garden?

(129)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

236. How often does (CHILD'S NAME) eat vegetables grown elsewhere in the local area? (e.g. NEIGHBOR'S GARDEN OR LOCAL FARMERS MARKET)

(130)
1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 239)
9 = DON'T KNOW (GO TO 239)

237. How often does he/she eat leafy green vegetables, (such as lettuce or spinach) grown elsewhere in the area?

(131)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

238. How often does he/she eat root vegetables, (such as beets or turnips) grown elsewhere in the area?

(132)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

YOUNG PERSON QUESTIONNAIRE
AGES 6 - 14 YEARS OLD

HOUSE ID __ __ __ __

PERSON ID __ __ __ __ __ __ __ __

QUESTIONS ABOUT THE CHILD 6-14 YEARS OLD MUST BE ANSWERED BY THE PARENT OR LEGAL GUARDIAN OF THE CHILD.

Child's full/legal name____

307. What is the highest year of education (CHILD'S NAME) has completed?

(027-029)

	(circle one)
No Schooling	000
Elementary School	001 002 003 004 005 006 007 008
High School (GED = 012)	009 010 011 012
REFUSED TO ANSWER	088
DON'T KNOW	099

IF CHILD IS 12 YEARS OR OLDER ASK 308 ON SMOKING, OTHERWISE, GO TO 309

308. Does (CHILD'S NAME) smoke or use tobacco products?

(030)

1 = Yes
2 = No (GO TO 309)
8 = REFUSED (GO TO 309)
9 = DON'T KNOW (GO TO 309)

Does he/she smoke/use TOBACCO PRODUCT?
(Circle responses)

			Yes	No	Don't know	IF YES, HOW MANY:
(031)	a.	Cigarettes	1	2	9	___ ___ Cigarettes per day, total (032-033) (1 pack=20)
(034)	b.	Cigars	1	2	9	___ ___ Cigars per day, total (035-036)
(037)	c.	Pipes	1	2	9	___ ___ Pipe bowls per day, total (038-039)
(040)	d.	Smokeless tobacco	1	2	9	___ ___ Times per day, total (041-042)

PERSON ID _ _ _ _-_ _ _ _

313. Where does (CHILD'S NAME) usually play when outdoors around the house?

(131)

1 = Back yard
2 = Front yard
3 = Side yard
7 = Other (specify) ________
9 = DON'T KNOW

314. Where does (CHILD'S NAME) usually play outdoors (in the last 90 days) when he/she is not playing in your own home yard?

(132-133)

01 = Neighbor's yard
02 = Playground
03 = Near or around creek or ditch
04 = On or near tailings or slag piles
05 = On sidewalks or streets
06 = Park
07 = Only plays at home
08 = Other (SPECIFY) ________________
99 = DON'T KNOW

315. Is the ground where (CHILD'S NAME) usually plays mainly grassy, concrete/asphalt, plain dirt or soil, just a sandbox, or some other stuff?

(134)

1 = Grassy
2 = Concrete/asphalt
3 = Dirt/soil
4 = Sandbox
7 = Other (SPECIFY) ________________
9 = DON'T KNOW

316. Does (CHILD'S NAME) often take food or a drink with him/her outside to play?

(135)

1 = Yes
2 = No
9 = DON'T KNOW

PERSON ID _ _ _ _-_ _ _ _

324. Does your household have a vegetable garden in your yard?

(143)
1 = Yes
2 = No (GO TO 329)
9 = DON'T KNOW (GO TO 329)

325. Has soil been hauled in and placed on your garden?

(144)
1 = Yes
2 = No
9 = DON'T KNOW

IF YES, SPECIFY FROM WHERE? ---------------------------

326. How often does (CHILD'S NAME) eat vegetables grown in your garden?

(145)
1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 329)
9 = DON'T KNOW (GO TO 329)

327. How often does (CHILD'S NAME) eat leafy green vegetables, (such as lettuce or spinach) grown in your garden?

(146)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

328. How often does (CHILD'S NAME) eat root vegetables, (such as beets or turnips) grown in your garden?

(147)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

PERSON ID ___ ___ ___ ___-___ ___ ___ ___

My last questions are about (CHILD'S NAME'S) activities.

333. In the last 90 day, has (CHILD'S NAME) participated in any of the following activities? (Circle all that apply.)

			Yes	No	Don't know
(152)	a.	Painted pictures with artists paints? (not children's paints)	1	2	9
(153)	b.	Painted, stained or refinished furniture?	1	2	9
(154)	c.	Painted the inside or outside of a home or building?	1	2	9
(155)	d.	Worked with stained glass?	1	2	9
(156)	e.	Cast lead into fishing sinkers, bullets or anything else?	1	2	9
(157)	f.	Worked with soldering in electronics?	1	2	9
(158)	g.	Worked on soldering pipes or sheets of metal?	1	2	9
(159)	h.	Repaired auto radiators?	1	2	9
(160)	i.	Worked on auto bodies or auto maintenance?	1	2	9
(161)	j.	Made pottery?	1	2	9
(162)	k.	Ridden a dirt bike, mountain bike, or ATV in the local area?	1	2	9
(163)	l.	Welded?	1	2	9
(164)	m.	Visited indoor firearm target ranges?	1	2	9
(165)	n.	Cleaned or repaired firearms	1	2	9

This completes the questionnaire. Do you have any questions or comments about it?

____

____

Thank you for your time.

TEENAGE AND ADULT QUESTIONNAIRE
AGES 15 - 44 YEARS

QUESTIONS ABOUT THE YOUNG ADULT AGED 15-16 MUST BE ANSWERED WITH THE PARENT OR GUARDIAN PRESENT.

400. QUESTIONS FOR SELECTED PERSON AGE 15 - 44.

HOUSE ID ___ ___ ___ ___

PERSON ID ___ ___ ___ ___ - ___ ___ ___ ___

What is your full/legal name?

____

PERSON ID _ _ _ _-_ _ _ _

407. What is the highest year of education you have completed?
(028-030)

(circle one)

No Schooling	000
Elementary School	001 002 003 004 005 006 007 008
High School (GED = 012)	009 010 011 012
Technical or Trade School	T13 T14
Junior or Community College	J13 J14
Four year College or University	013 014 015 016
Graduate School (or higher)	017
REFUSED TO ANSWER	088
DON'T KNOW	099

CIGARS

(045) 410. Have you smoked at least 50 cigars during your entire life?
1 = yes
2 = no (GO TO QUESTION 411)
8 = REFUSED TO ANSWER
9 = DON'T KNOW

(046) 410.1 Do you smoke cigars now?
1 = yes
2 = no (GO TO QUESTION 410.2)
8 = REFUSED TO ANSWER (GO TO 410.2)
9 = DON'T KNOW

410.1.1 On the average, how many cigars a week do you now smoke?
(047-048) __ __ (NOW GO TO QUESTION 410.3)

410.2 How long has it been since you smoked cigars?

(049-050) __ __ years
00 = under 1 year
88 = REFUSED
99 = DON'T KNOW

410.3 On the average of the entire time you smoked, how many cigars did you smoke per week?
(051-052) __ __ cigars per week
88 = REFUSED
99 = DON'T KNOW

410.4 About how old were you when you first started smoking cigars regularly?
(053-054) __ __ years old
88 = REFUSED
99 = DON'T KNOW

410.5 For how many years WERE YOU/HAVE YOU BEEN a cigar smoker, not including the time you may have stayed off cigars?
(055-056) __ __ years
88 = REFUSED
99 = DON'T KNOW

PERSON ID _ _ _ _-_ _ _ _

CHEWING TOBACCO

412. Have you used chewing tobacco at least 20 or more times during your entire life?

(069)
1 = yes
2 = no (GO TO QUESTION 413)
8 = REFUSED TO ANSWER
9 = DON'T KNOW

412.1 Do you chew tobacco now?

(070)
1 = yes
2 = no (GO TO QUESTION 412.2)
8 = REFUSED TO ANSWER (GO TO 412.2)
9 = DON'T KNOW

412.1.1 On the average, how many plugs, twists, or pouches do you chew a week?

(071-072) ___ ___ (NOW GO TO QUESTION 412.3)

412.2 How long has it been since you chewed tobacco?

(073-074) __ __ years
00 = under 1 year
88 = REFUSED
99 = DON'T KNOW

412.3 On the average of the entire time you chewed tobacco, how many plugs/twists/or pouches did you chew a week?

(075-076) ___ ___ per week
88 = REFUSED
99 = DON'T KNOW

412.4 About how old were you when you first started chewing tobacco regularly?

(077-078) __ __ years old
88 = REFUSED
99 = DON'T KNOW

412.5 For how many years HAVE YOU/DID YOU chew tobacco, not including the time you may have stayed off chewing tobacco?

(079-080) __ __ years
88 = REFUSED
99 = DON'T KNOW

ALCOHOL

Now I have a few questions on alcohol consumption.

(093) 414. Did you ever drink alcoholic beverages?
1 = Yes
2 = No (GO TO QUESTION 415)
8 = REFUSED
9 = DON'T KNOW

(094) 414.1 Do you presently drink alcoholic beverages?
1 = Yes (GO TO QUESTION 414.1.2)
2 = No
8 = REFUSED TO ANSWER (GO TO QUESTION 415)
9 = DON'T KNOW (GO TO QUESTION 415)

(095-096) 414.1.1 How old were you when you quit?

__ __
88 = REFUSED TO ANSWER
99 = DON'T KNOW

(097-098) 414.1.2 How old were you when you began drinking alcoholic beverages?

__ __
88 = REFUSED TO ANSWER
99 = DON'T KNOW

(099-100) 414.1.3 On the average, how many drinks a week do you have? (1 DRINK = 1 BEER, 1 SHOT LIQUOR OR MOONSHINE, 1 GLASS WINE OR WINE COOLER)

__ __
88 = REFUSED TO ANSWER
99 = DON'T KNOW
LESS THAN 1/week = 00

The next set of questions are about activities and jobs you may have.

416. In the last 90 days have you worked as a miner or in a mining related job such as mine material handling or transportation?

(171)
1 = Yes
2 = No (GO TO 423)
9 = DON'T KNOW (GO TO 423)

417. What type of mine work did you do in the last 90 days? (Circle all that apply.)

			Yes	No	DON'T KNOW
(172)	a.	Underground	1	2	9
(173)	b.	Surface	1	2	9
(174)	c.	Milling	1	2	9
(175)	d.	Transportation/ handling	1	2	9
(176)	e.	Clerical/Admin.	1	2	9
(177)	f.	Smelter	1	2	9
(178)	g.	Other	1	2	9

IF OTHER, specify: ____________________

418. What type of mine did you work in the last 90 days? (Circle all that apply.)

			Yes	No	Don't know
(179)	a.	Lead	1	2	9
(180)	b.	Zinc	1	2	9
(181)	c.	Silver	1	2	9
(182)	d.	Molybdenum	1	2	9
(183)	e.	Coal	1	2	9
(184)	f.	Limestone	1	2	9
(185)	g.	Clay	1	2	9
(186)	h.	Other	1	2	9

IF OTHER, SPECIFY: ____________________

419. What is the name of the place where you work (have worked)?

____

420. How long have you worked (did you work) there, in years and months?

___ ___ Years (187-188)   ___ ___ Months (189-190)

421. Do (did) you change out of your work clothes and leave them at work?

(191)
1 = Always
2 = Sometimes
3 = Never
9 = DON'T KNOW

422. Do (did) you shower at work before coming home?

(192)
1 = Always
2 = Sometimes
3 = Never
9 = DON'T KNOW

(215)	w.	Paint, glaze, and ink manufacture?	1	2	9
(216)	x.	Rubber manufacture?	1	2	9
(217)	y.	Scrap metal recovery?	1	2	9
(218)	z1.	Other lead related job or activity?	1	2	9
		SPECIFY______________			
(219)	z2.	Other cadmium related job or activity	1	2	9
		SPECIFY______________			

424. Have you done any of the following activities in the last month?

			Yes	No
(220)	a.	Painted a house or building inside or out?	1	2
(221)	b.	Painted or refinished furniture?	1	2

428. Does your household have a garden in your yard? (VEGETABLE OR FLOWER)

(262)
1 = Yes
2 = No (GO TO 434)
9 = DON'T KNOW (GO TO 434)

429. IF YES, Do you frequently till, plant or work the garden yourself?

(263)
1 = Yes
2 = No
9 = DON'T KNOW

430. Has soil been hauled in and placed on your garden?

(264)
1 = Yes
2 = No
9 = DON'T KNOW
IF YES, Specify from where ________________

431. How often do you eat vegetables grown in your garden?

(265)
1 = Once a week or more
2 = Less than once per week
3 = Never (GO TO 434)
9 = DON'T KNOW (GO TO 434)

432. How often do you eat leafy green vegetables, (such as lettuce or spinach) grown in your garden?

(266)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

433. How often do you eat root vegetables, (such as beets or turnips) grown in your garden?

(267)
1 = Once a week or more
2 = Less than once per week
3 = Never
9 = DON'T KNOW

PERSON ID _ _ _ _ _ _ _

MEN: GO TO END

FOR WOMEN ONLY:

Now I have a couple questions on pregnancy and birth control pills. I ask these questions because they can affect the results of the blood tests we will be doing.

438\. Are you pregnant?
(272)
1 = Yes (GO TO END)
2 = No
7 = Not applicable (male subject)
8 = REFUSED
9 = DON'T KNOW

439\. Are you taking birth control pills?
(273)
1 = Yes
2 = No
7 = Not applicable (male subject or 438 answered YES)
8 = REFUSED
9 = DON'T KNOW

END:

This completes the questionnaire. Do you have any questions or comments about it?

____

____

____

____

Thank you for your time.

ATTACHMENT [illegible]

MRI REPORT

Multistate Lead and Cadmium Exposure Study with the States of Missouri, Kansas, and Illinois

Summary Report

For Agency for Toxic Substances and Disease Registry (ATSDR)

Contract No. 205-90-0839
Work Authorization No. 1

MRI Project No. 9723-A

March 2, 1992

MIDWEST RESEARCH INSTITUTE 425 Volker Boulevard, Kansas City, MO 64110-2299 • (816) 753-7600

SECTION 1

EXECUTIVE SUMMARY

1.1 BACKGROUND

The Agency for Toxic Substances and Disease Registry (ATSDR) developed a multisite approach to examine the interdependence between environmental contaminant sources, human behavior, and socioeconomic factors that may influence blood lead levels in susceptible populations.

Three sites on the National Priority List (NPL) came to the attention of ATSDR as areas where residents require additional health evaluations. Lead and cadmium are the contaminants of specific concern. The NPL's sites included in this study are (1) Joplin, Jasper County, Missouri; (2) Cherokee County Subsite in Galena, Kansas; and (3) NL Industries/Taracorp Site in Granite City, Madison County, Illinois. The primary media and route for potential exposure at each of these sites are high soil concentrations of lead and cadmium.

Health officials in each of the three states represented agreed to participate in conducting exposure studies to assess the degree to which residents were being exposed. The similarity in study design for the three sites made it feasible to include the individual studies in a larger multisite study approach. During the months of November 1990 through March 1991, ATSDR met with representatives and officials from the three State Departments of Health who agreed to participate in the Multistate Study.

1.2 OBJECTIVES

ATSDR, through Contract No. 205-90-0839, assigned Midwest Research Institute (MRI) the responsibility to provide laboratory services and support the collection of biological data for the Multistate Study. MRI's objectives for the project were:

- To collect, process, store, and transport blood and urine specimens from study participants to the Centers for Disease Control/Center for Environmental Health and Injury Control (CDC/CEHIC) for analysis for lead, cadmium, free erythrocyte protoporphyrin (FEP), alanine-amino peptidase (AAP), gamma-glutamyltransferase (GGT), N-acetyl β-glucosamindase (NAGA), creatinine, and several immunological indicators.

- To provide analysis services for routine blood and urine tests, using local hospitals and Roche Biomedical Laboratories (Roche) in Kansas City, Missouri.

- To implement a Quality Assurance/Quality Control (QA/QC) program to assess the quality of the data from the routine blood and urine tests and to provide comprehensive and traceable data to ATSDR.

1.3 SUMMARY OF RESULTS

MRI supplied qualified personnel to collect blood and urine specimens from 1,705 study participants at the three study sites and to process, store, and transport the specimens for the analytical tests shown in Tables 1 and 2. The sites, number of participants, and dates of collection were as follows:

Site	Number of participants	Dates of collection
Joplin, Missouri	701	July 16-August 27, 1991
Galena, Kansas	163	September 10-30, 1991
Granite City, Illinois	841	August 22-September 20, 1991

Summaries of the number of specimens collected for specific tests are shown in Tables 3 and 4. Control and replicate specimens were generated at the rates of 15% and 10%, respectively, of the number of participants for the routine blood and urine tests shown in Table 4. Table 5 is a summary of the number of specimens generated for each QA/QC specimen type.

1.4 ORGANIZATION OF REPORT

The remainder of this report provides detail on project organization (Section 2); preliminary activities (Section 3); collection, processing, storage, and transport of specimens (Section 4); analysis activities (Section 5); and collection, analysis, and QC results (Section 6). The Appendices contain the CDC/CEHIC laboratory protocol, examples of documentation forms, and detailed collection results and QC data for the control and replicate specimens.

Table 1. BLOOD SPECIMEN COLLECTION

Blood tests	Collection tube type	No. of tubes	Volume required	Special handling	Shipping instructions
Lead[a]	EDTA	b	0.5 mL	4°C	Overnight/batch
Cadmium[a]	EDTA	b	0.5 mL	4°C	Overnight/batch
FEP[a]	EDTA	b	0.5 mL	4°C	Overnight/batch
CBC[c]	EDTA	1	1 mL	8 h/on ice	Local/daily
Immunoglobulin[e]	Red top	d	—	Freeze	Overnight/batch
Biomedical tests[e]	Red top	d	3 mL	4°C	Overnight/batch
Immune panel[a]	Heparinized	1	1.5 mL	Control room temp.	Overnight/daily
Total volume			7.0 mL		

[a] Analysis by CDC/CEHIC.
[b] One tube was used to collect the blood for Pb, Cd, and FEP.
[c] Analysis by local hospital laboratories.
[d] One tube was used to collect the blood for the IgG and biomedical tests.
[e] Analysis by Roche Biomedical Laboratories.

Notes:

A. Tests listed by priority for collection and analysis.

B. Syringe and butterfly/vacutainer apparatus was used to collect specimens from children ages 6 mo through 6 yr old.

C. The immunoglobulin test was performed from a 0.5-mL aliquot of the serum collected for the biomedical tests.

Table 2. URINE SPECIMEN COLLECTION

Analyte	Specimen	Volume	Preparation
Cadmium[a]	On-site void	10 mL	HNO_3
GGT/AAP[a]	On-site void	10 mL	Glycerol
NAGA[a]	On-site void	5 mL	No preservative
Creatinine[a]	On-site void	5 mL	No preservative
Urinalysis[b]	On-site void	5 mL	No preservative

[a] Frozen immediately (−20°C), stored, and shipped with dry ice overnight. Analysis by CDC/CEHIC.
[b] Stored at 4°C. Analysis by local hospital laboratories.

SECTION 2

PROJECT ORGANIZATION

Midwest Research Institute (MRI) worked with ATSDR and the Principal Investigators (PIs) from each of the states to plan, coordinate, and conduct the Multistate Study. The overall project organization is shown in Figure 1.

As cited previously, MRI's responsibilities included collecting, processing, storing, and transporting blood and urine specimens to the various laboratories for specific chemical and biomedical analyses, implementing a QA/QC program that was initiated at the collection site, and providing comprehensive and traceable data to ATSDR.

Specific activities performed by MRI to achieve the objectives of the Multistate Study included:

- Providing qualified personnel to work at each study site to collect, process, store, and transport blood and urine specimens as specified in the Revised Work Plan. Phlebotomists and lab staff were recruited near the study sites to perform this work.

- Contracting with Roche Biomedical Laboratories (Roche) to perform the blood chemistry panel specified in the Revised Work Plan.

- Contracting with a hospital laboratory near each site to perform complete blood counts (CBC) and routine urinalyses (UA) for all specimens.

- Coordinating all collection activities with the Missouri, Kansas, and Illinois Departments of Health Principal Investigators (PIs).

- Applying QA/QC procedures to maintain specimen integrity, and providing control specimens and replicate analyses as required.

- Providing appropriate documentation to track all specimens (using a unique ID number) through collection, processing, storage, and transport.

- Transporting all specimens to CDC/CEHIC, Roche, and local hospital laboratories for analysis under specified storage conditions.

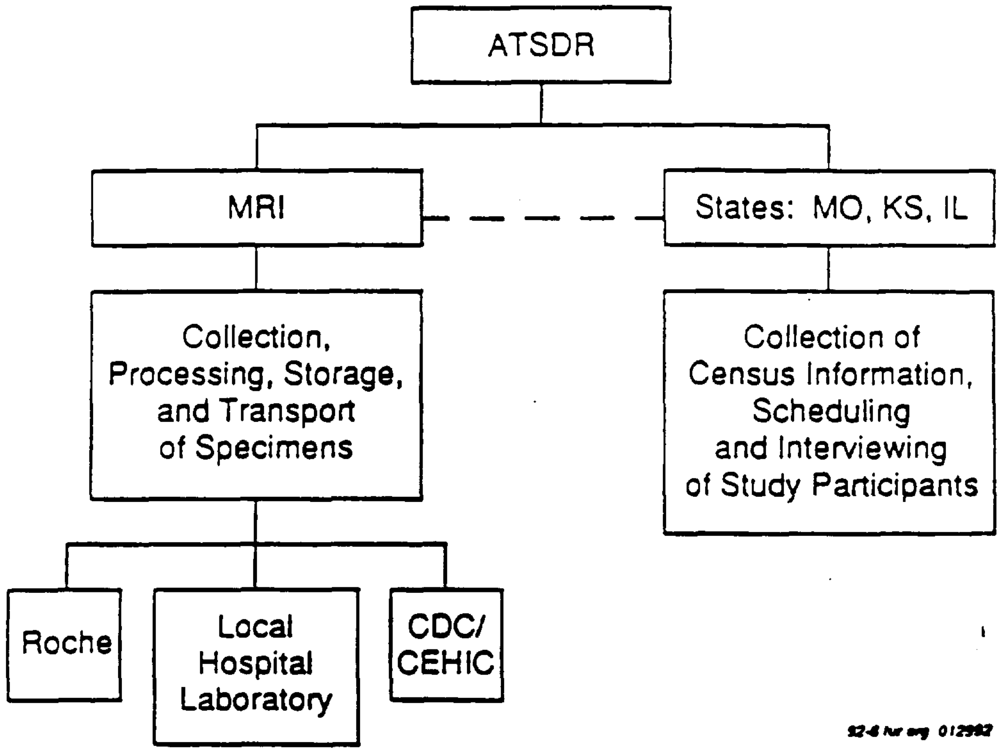

Figure 1. Overall project organization.

- Providing analysis results by unique ID number for each specimen to ATSDR for the routine blood and urine tests and biomedical tests. The test results provided by the local laboratories and Roche were reported to MRI, reviewed, compiled, and transferred by magnetic tape to ATSDR.

MRI's day-to-day project management included the following responsibilities:

- Daily contact with the on-site coordinator and PI.
- Receipt of copies of collection and shipping summaries.
- Receipt, review, and compilation of hard copy analysis results from Roche and local hospital laboratories.
- Evaluation of blind QC results received with each set of analysis results.
- Transcription of hard copy data onto a magnetic tape.
- Reporting status of the project to the ATSDR project officer in required weekly and monthly reports and as needed.

SECTION 3

PRELIMINARY ACTIVITIES

Several planning meetings were held with ATSDR, States, MRI, and CDC/CEHIC staff between November 1990 and initiation of the study, including a planning meeting in Atlanta in March 1991, which was attended by staff from all the agencies. These meetings were held to clarify the work and to define the responsibilities of all agencies involved in the Multistate Study. MRI prepared a work plan for the Multistate Study in response to a work assignment request from ATSDR dated April 8, 1991. MRI's work plan was reviewed by ATSDR and subsequently revised to address specific comments. MRI's work plan dated May 24, 1991 was followed throughout the Multistate Study. A laboratory protocol for collection, processing, storage, and transport of specimens was supplied by CDC/CEHIC and is included as Appendix A.

Planning meetings were also conducted by MRI with local hospitals, Roche, local labor resources, and couriers/shippers to arrange analysis services, labor, and transport of specimens for the Multistate Study. These planning meetings included prestudy site visits to evaluate collection facilities and shipping logistics. Preliminary trials were conducted immediately before collection dates to ensure that all personnel were properly trained.

Data management was planned in conjunction with the ATSDR Project Officer and Data Manager. A meeting was held at MRI on July 10, 1991, to discuss the data management requirements, and subsequent planning with a local transcription service followed. A test tape containing results from the CBC, UA, and blood chemistry tests was submitted to ATSDR on September 17, 1991, and was approved on September 30, 1991.

Additional details on the preliminary activities for each study site follow.

SECTION 4

COLLECTION, PROCESSING, STORAGE, AND TRANSPORT OF SPECIMENS

Specimens were collected, processed, stored, and transported according to the laboratory protocol supplied by CDC/CEHIC (Appendix A). Specific information regarding staff, facilities, supplies, scheduling, storage, and transport follows.

4.1 ON-SITE STAFF

Phlebotomy support was arranged through Roche for the Joplin, Missouri, and Galena, Kansas, studies. One phlebotomist worked through both studies, but backup staff was provided by Roche on occasion. College students and temporary help provided urine collection, processing of specimens, and on-site coordination for the Missouri and Kansas studies. The hospital staff at St. Elizabeth Medical Center provided phlebotomy service, urine collection, specimen processing, and on-site coordination for the Granite City, Illinois, study.

All staff were trained by MRI and CDC/CEHIC staff during the preliminary trials held at the sites prior to initiation of the collection. The CDC/CEHIC laboratory protocol (Appendix A), the MRI Revised Work Plan, and supporting documentation forms (Appendix B) were used in the training. Figure 4 shows the overall collection, processing, storage, and transport scheme which was used for the Multistate Study. All handling and packaging of specimens were performed in compliance with the following documents:

- Memorandum of Instructions for Packaging and Shipping of Biomedical Materials, October 24, 1988 (supplied by ATSDR).
- 42 *CFR* Part 72—Interstate shipment of Etiologic Agents.
- MMWR August 21, 1987—Recommendations for Prevention of HIV Transmission in Health-Care Settings.
- MMWR June 24, 1988—Universal Precautions for Prevention of Transmission of HIV Virus, Hepatitis B Virus, and Other Blood-borne Pathogens in Health-Care Settings.

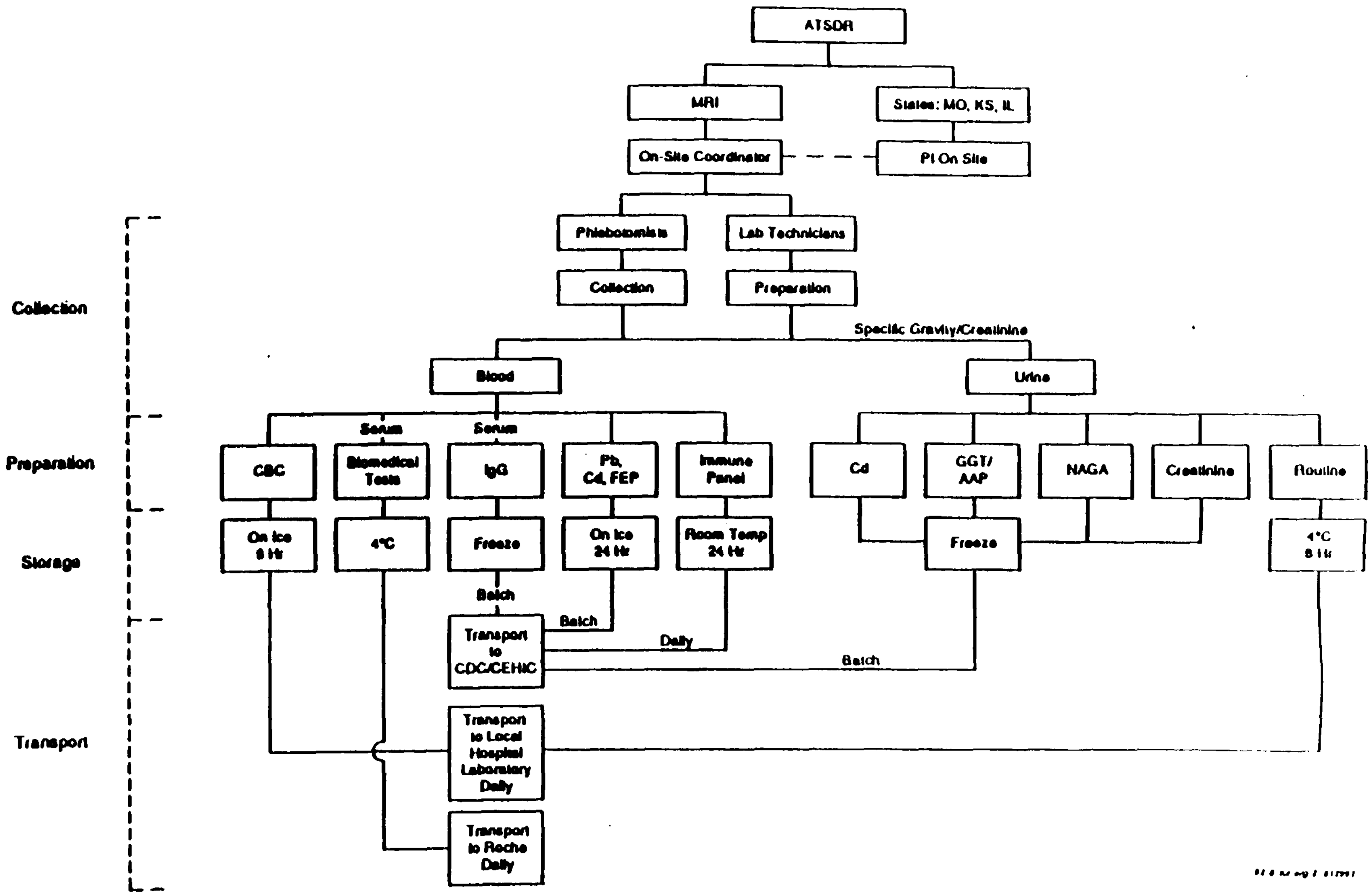

Figure 4. Collection, processing, storage, and transport of specimens.

All on-site personnel who were involved with collecting, processing, storing, or packing specimens for transport were instructed on the regulations and the correct means of handling and packaging the specimens. Copies of the above listed documents were available at each collection site. As a safety precaution, a solution of 5,000 ppm sodium hypochlorite (1:10 dilution of household bleach in water) was available at each collection site to decontaminate any spills that might have occurred.

Supervision of the staff was provided by the on-site coordinator hired by MRI, and was supported by technical advice provided by the PI on site and CDC/CEHIC staff by telephone.

4.2 COLLECTION FACILITIES

The collection facilities were selected by the States with several considerations in mind, including convenience to participants, privacy, availability of bathrooms, utilities, telephones, storage, safety, and cleanliness. Details regarding each collection facility follow.

4.2.1 Joplin, Missouri

Specimens from the study population were collected from July 16 through August 6 at the Jasper County Health Department. Blood collection and processing was performed in a partitioned area in an upstairs office. The urine specimens were collected and processed in a downstairs laundry area convenient to the restrooms and the waiting area. Since no fume hood facilities were available, urine specimens needing the addition of nitric acid were taken daily to a local university to perform that function. A room was available for storage of specimens and extra supplies. A phone was installed by the State, and copies of collection logs were made at a nearby library. No telefaxing service was available.

Collection activities were moved to the Neosho Auditorium on August 7 where specimens from the control population were collected through August 27. Blood collection and processing was performed in a stairwell area, and the urine specimens were collected and processed in a partitioned area convenient to the restrooms. No fume hood facility was available, so urine specimens needing the addition of nitric acid were taken to a nearby hospital pharmacy to perform that function. A closet was used for the storage of extra supplies. A telephone and copy machine were available for use as needed. No telefaxing service was available.

4.2.2 Galena, Kansas

The Baxter Memorial Hospital (non-operating) facility was used for the collection of specimens from both the study and control participants. Blood collection and processing were performed in the hospital pharmacy. A patient room with a restroom was used for urine collection and processing. A fume hood was available in the pharmacy for the nitric acid addition to selected urines. There was sufficient space in the collection areas for storage of extra supplies. A telephone and copy machine were available for use as needed. No telefaxing service was available.

4.2.3 Granite City, Illinois

Specimens from the study and control populations were collected at St. Elizabeth Medical Center. A large room, which was convenient to restrooms and the waiting area, was set up for blood and urine processing. There was sufficient space in the collection area for storage of extra supplies. A telephone, copy machine, and telefax machine were available for use as needed.

4.3 COLLECTION SUPPLIES

Collection supplies for the Multistate Study were provided by CDC/CEHIC, MRI, and the States. Table 6 gives a summary of the supplies used and by whom they were provided.

4.4 SCHEDULING PARTICIPANTS

Scheduling participants for interviews and specimen collection was performed by staff from the individual States. Scheduling was adjusted based on the number of participants, the time of the first and/or last appointment, shipping restrictions, and the CDC/CEHIC work load. Generally, the days and hours of operation for each site were as follows.

Site	Hours of Operations
Joplin, MO	M-F, varied hours
Galena, KS	M,W—3 p.m. to 8 p.m.; T,Th—11 a.m. to 6 p.m.
Granite City, IL	M-F, 8 a.m. to 8 p.m.

These hours were adjusted as necessary based on the factors mentioned above. The schedules were given by the State's PI to MRI's on-site coordinator on a daily basis.

Table 6. SUMMARY OF COLLECTION SUPPLIES PROVIDED BY CDC/CEHIC,MRI, AND THE STATES[a]

Supplier	Supplies
CDC/CEHIC	Screened collection supplies (for Pb and Cd specimens) Containers for other specimens analyzed by CDC/CEHIC. Protocol, collection logs Specimen labels Shipping containers Band-Aids™, gauze
MRI	Serum separator and transfer tubes (through Roche) Centrifuge (through Roche) Urine tubes (through local hospitals) Slides for blood smears (through local hospitals) Facility equipment Paperwork Shipping supplies Slide mailers Juice, toys, candy, Band-Aids™
Missouri	Candy, toys
Kansas	None
Illinois	Juice, toys, McDonald's® certificates

[a] Some supplies were provided jointly by more than one agency participating in the study.

4.5 STORAGE OF SPECIMENS

Specimens were stored according to the conditions identified in Tables 1 and 2 and shown in Figure 4. Prior to transport, room temperature specimens were stored at ambient temperature, refrigerated specimens in a refrigerator, and frozen specimens in a freezer. During transport, room temperature was maintained in the insulated shipping container by enclosing unfrozen cold packs, and refrigeration and freezing was maintained by enclosing frozen cold packs and dry ice, respectively, in the insulated shipping containers.

4.6 TRANSPORT OF SPECIMENS

MRI arranged the transport of all specimens to local hospitals, Roche, and CDC/CEHIC. Specimens for CBC and UA were delivered to the local hospital laboratories at least twice a day by MRI's on-site staff. The blood chemistry specimens were transported to Roche in Kansas City by their courier (Missouri and Kansas) or Flexfleet courier (Illinois). The specimens collected for the immune panel were shipped daily to CDC/CEHIC. The remaining specimens (frozen blood serum and urine) were batched and shipped to CDC/CEHIC at least once a week.

Specimens going to CDC/CEHIC were transported by Flexfleet couriers to the nearest major airport (Missouri and Kansas—Tulsa, Oklahoma; Illinois—St. Louis, Missouri), flown to Atlanta by Delta Dash, and delivered to CDC/CEHIC by Dependable Courier. Shipments were scheduled for overnight service with delivery to CDC/CEHIC by 10 a.m. The only exception was Granite City, Illinois, where Federal Express was used on Fridays, with Saturday delivery by noon.

4.7 REDRAWS

A second blood specimen was collected and transported to CDC/CEHIC for analysis for those participants found to have elevated blood lead levels. The collection and transport was arranged by MRI, using the same phlebotomists hired for the studies.

For the Joplin, Missouri study, 12 blood specimens for lead analysis were collected from participants having blood levels > 15 µg/dL. Six of the specimens were drawn during the Galena, Kansas collection in September, 1991; four were drawn at the Jasper County Health Department and two at the Joplin Health Department on September 25, 1991, and November 22, 1991, respectively. For the Galena, Kansas, study, redraws for blood lead analysis were performed on December 23, 1991, for three participants with blood lead levels of > 15 µg/dL. The collection was performed in the participants' homes.

Forty-seven redraws were performed January 6-15, 1992, at St. Elizabeth Medical Center in Granite City, Illinois for those participants with blood lead levels of > 10 µg/dL.

All of the blood lead specimens were refrigerated prior to and during shipment to CDC/CEHIC for analysis.

SECTION 5

ANALYSIS ACTIVITIES

Analysis activities performed by MRI for the Multistate Study included clinical chemistry support, data management, and Quality Assurance/Quality Control. Details about each of these analysis activities are given in this section.

5.1 CLINICAL CHEMISTRY SUPPORT

MRI was responsible for the recruitment, training, and QC oversight of the laboratories hired to perform the CBC, UA, and blood chemistry analysis. Local hospital laboratories were recruited to perform the CBC and UA, primarily due to the need to complete these analyses within 8 hrs of collection. The laboratory managers were provided lists of the tests required for the studies, and performed as the primary contact point for the MRI project leader to obtain status reports. The CBCs were performed on a Coulter Counter instrument; UAs on a Clinitek® 200.

Roche was recruited to perform the blood chemistry panel primarily due,to the Kansas City location and the need to use one laboratory for all three sites of the Multistate Study. The laboratory manager was provided a list of analytes desired for the study, and a custom panel of test results was arranged by Roche. Day-to-day contact to obtain status reports on analyses was maintained with the laboratory staff. The instrument used for the blood chemistry panel was an Olympus DEMAND.

The analysis laboratories and the tests they performed are shown in Table 7. Specific components of those tests are shown in Tables 8 and 9.

5.2 DATA MANAGEMENT

Hard copy test results for individual participants were received at MRI from Roche and the local hospital laboratories. These data were compiled by MRI staff into individual files for each participant (by unique ID number), for each control, and for each replicate. The participant test results were copied and sent to a transcription service (Datatran, Kansas City, Missouri) where the data tapes were prepared using double entry procedures. The data tapes were 1600 bits per inch (bpi) in IBM format (EBCIDIC).

Table 7. LABORATORIES PROVIDING CLINICAL CHEMISTRY SUPPORT FOR THE MULTISTATE STUDY

Laboratory	Study site	Test performed
Roche Biomedical Laboratory 1706 North Corrington Avenue Kansas City, MO 64120	MO, KS, IL	Blood chemical panel Reticulocyte count[a]
Freeman Hospital 1102 West 32nd Street Joplin, MO 64804	MO, KS	Complete blood count, excluding reticulocyte count Urinalysis
St. Elizabeth Medical Center 2400 Madison Avenue Granite City, IL 62040	IL	Complete blood count, including reticulocyte count Urinalysis

[a] Performed by Roche for the MO and KS studies due to labor limitations at Freeman Hospital.

Table 8. BIOMEDICAL TESTS (SERUM)

Test	Reference range[a]		Expected coefficient of variability (%)[a]
AST (SGOT)[b]	0-6 mo 7-12 mo 1-5 yr 6-10 yr > 10 yr	0-120 IU/L 0-110 IU/L 0-75 IU/L 0-60 IU/L 0-50 IU/L	5.41
ALT (SGPT)[c]		0-50 IU/L	8.33
GGT[d]	Male Female	0-65 IU/L 0-45 IU/L	6.45
Albumin		3.5-5.5 g/dL	2.78
Total protein	Newborn < 2 yr ≥ 2 yr	4.6-7.2 g/dL 5.7-8.2 g/dL 6.0-8.5 g/dL	3.23
Creatinine		0.5-1.5 mg/dL	4.76
BUN[e]		7-26 µg/dL	7.14
Electrolytes Sodium Potassium Chloride		 135-148 mEq/L 3.5-5.5 mEq/L 94-109 mEq/L	 1.43 2.44 1.98

[a] Provided by Roche Biomedical Laboratories.
[b] Aspartate Aminotransferase.
[c] Alanine Aminotransferase.
[d] Gamma-Glutamyltransferase.
[e] Blood Urea Nitrogen.

Table 9. ROUTINE BLOOD AND URINE TESTS

Specimen	Test
Blood	CBC to include: Hemoglobin and hematocrit White blood cell count and differentials[a] Red blood cell count, indices, and morphology Platelet estimate and reticulocyte count
Urine	Chemical urinalysis (routine dipstick) Microscopic urinalysis, if indicated Specific gravity

[a] Two blood slides will be prepared for manual determination of differential.

The number of records and participant ID numbers were verified at MRI prior to submission of the data tapes and corresponding bound data summary sheets for each site to ATSDR on December 20, 1991.

Slide mailers containing blood smears for manual differential were received at MRI from the local hospitals. The mailers were labeled with the patient ID number and packed numerically by site in labeled shipping boxes. The blood smear slides and bound inventories for each site were submitted to CDC/CEHIC on November 1 (Missouri) and November 26 (Kansas and Illinois).

The flow of project data at MRI is summarized in Figure 5.

5.3 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control activities performed by MRI included documentation, generation of controls, replicates and blanks, and review of test results for the routine blood and urine tests.

5.3.1 Documentation

Standard laboratory QA/QC procedures and guidelines were applied to ensure that specimen integrity was maintained throughout collection, processing, storage, and transport. These procedures and guidelines included:

- Training of personnel by MRI in the procedures incorporated into the specimen collection and shipping protocol supplied by CDC/CEHIC and the MRI work plan. A copy of the protocol and associated work plan elements was available at each collection site for reference.

- Application of replicate labels containing a unique ID number to all specimens associated with a study participant. These sequential numbers were supplied by Mr. Charles Dodson of CDC/CEHIC, and were blind to the analysis laboratories.

- Application of the unique ID number for blind replicates to the paperwork for the participant from whose specimen the replicate was prepared.

- Documentation of the collection and processing of each specimen on the collection logs.

- Documentation of the generation of quality control specimens on a daily QA/QC log.

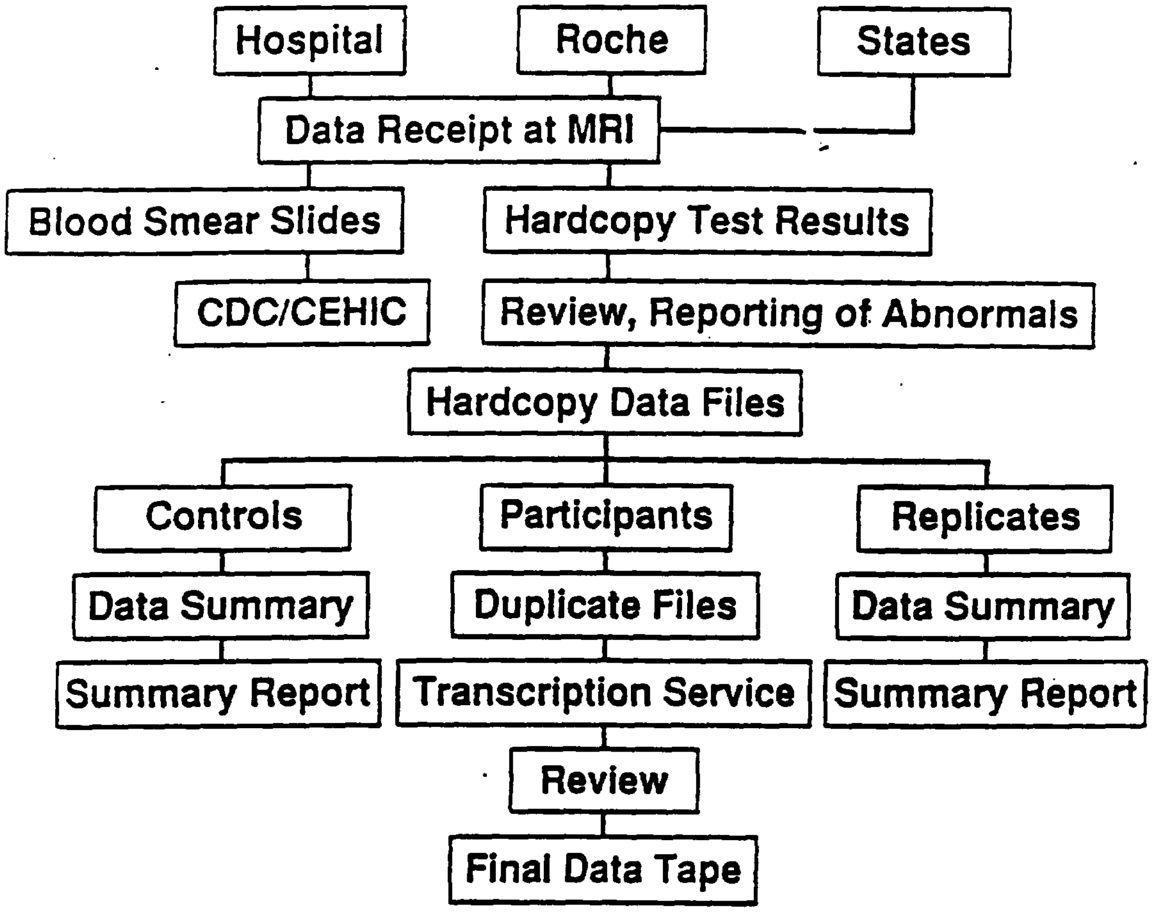

Figure 5. Flow of project data at MRI.

INTRODUCTION

The NL Industries/Taracorp Site (henceforth Taracorp) is located in a mixed industrial and residential area of Granite City (Madison County), Illinois. Taracorp is one of 41 National Priority List (NPL or Superfund) hazardous waste sites in Illinois. For the State of Illinois, the Illinois Department of Public Health (IDPH), in conjunction with the Agency for Toxic Substances and Disease Registry (ATSDR), evaluates each Superfund site's potential to harm public health.

The exposure study described here was undertaken as part of a larger study of Superfund sites with lead contamination in several states. The objectives of the Illinois part of the Multistate Lead and Cadmium Exposure Study were as follows:

1. To determine the concentration of lead and cadmium in blood and urine in target populations.
2. To determine the level of lead and cadmium contamination in environmental media in target areas.
3. To compare these levels with levels of contamination and ~~[illegible]~~ of blood and urine levels observed in comparable non-target areas.

Other parts of the multistate study not reported here include three mining and/or smelting sites in other states where the potential for exposure to lead and cadmium also existed. The objectives in these studies are similar. Cadmium is not present in higher than background concentrations in the Granite City area; however, cadmium data were collected for the sake of consistency.

BACKGROUND

The population within a three mile radius of the Taracorp site numbers 34,000 and the closest residents live within 100 yards of the boundary. Although the site is located in Granite City, two other towns, Madison and Venice are also located in close proximity to the site. A map is attached to illustrate the area (Figure 1).

Industrial history

Operations at the present Taracorp site started in 1895 as Markle Lead Works. Markle Lead Works manufactured lead shot and clay pigeons. Fire destroyed most of the facility in November, 1900. In 1901, the plant was rebuilt and included a lead smelter. Between 1901 and 1903, processes at the site included manufacturing lead shot, sealing wax, mixed metal, rolled sheet metal, and dross refining[1]. Between 1895 and 1903, Hoyt Metals purchased the site from Markle Lead Works. In 1903, United Lead purchased the smelter from Hoyt Metals. After 1903, secondary smelting capabilities were added[2]. In 1928, NL Industries (formerly National Lead Company) acquired the smelter from United Lead. Battery recycling began in the 1950s. In 1979, NL Industries sold the site to its present owner, Taracorp Industries.

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[1] Dross is the name given waste products or impurities from the surface of molten metal.

[2] Secondary smelting is the process of smelting lead-bearing materials other than ores such as slag or matte (a by-product of smelting containing metal sulfides and metal oxides).

Taracorp operated a secondary smelter with the capacity to produce 22,000 tons of lead products per year. In 1983, Taracorp ceased smelting in an effort to reduce lead air emissions, but continued to operate the metal refining and fabricating facilities at the site. A slag storage area is located on the southern boundary of the site. A preliminary site assessment performed in May 1983 estimated that 200,000 tons of lead waste were present at the site. Most of this waste was in and around the slag storage area. The slag storage area contains slag, metallic lead, lead oxide, cadmium, arsenic, iron oxide, silica, rubber and plastic battery cases, general refuse, drums and matte.

St. Louis Lead Recyclers (SLLR) borders Taracorp on its southwest boundary. St. Louis Lead Recyclers was established in 1980 and was originally intended to reclaim lead from batteries. In 1982, St. Louis Lead Recyclers reached an agreement with Taracorp, allowing them to recycle various materials from the Taracorp waste pile. Between 1981 and 1983, it has been estimated that SLLR processed approximately 11,000 tons of Taracorp's waste pile. Materials that could not be recycled (i.e., slag and hard rubber) were placed southwest of the waste pile. In June 1983, SLLR discontinued recycling lead from the waste pile.

Trust 454, Terminal Railroad Associates Inc., Illinois Central Gulf Railroad, Chicago and Northwestern Railroad, and Tri-Cities Trucking Inc. own properties bordering the site. St.

Louis Lead Recyclers is the present tenant on the land owned by Trust 454.

The former secondary lead smelter contributed to off-site soil contamination during eighty years of airborne lead emissions related to smelting, surface run-off, and fugitive dust emissions from contaminated on-site surface soil and waste piles. The United States Environmental Protection Agency (USEPA) placed the site on the NPL in 1984. Taracorp ceased smelting operations shortly afterward.

Characterization of site prior to the study

Soil

Soil samples collected on-site in 1988 contained lead in concentrations ranging from 1,500 to 48,000 mg/kg (ppm). Slag piles and other surface waste are estimated to contain up to 300,000 mg/kg (ppm) of lead. Cadmium soil concentrations in 37 samples ranged from <2 mg/kg to 12 mg/kg. Off-site samples collected from residential yards and gardens revealed lead concentrations that ranged from 106 to 9,493 ppm (mean = 1,030 ppm, median = 905, n = 40) and cadmium concentrations of 0.4 to 15.7 mg/kg.

Surface water

The two main surface water bodies, the Mississippi River and Horseshoe Lake, are some distance from the site and are monitored frequently. They have shown no evidence of site-related heavy metal contamination.

Air

Ambient air monitoring was performed throughout the late 1970s and early 1980s. Air lead levels taken from monitors closest to the site regularly exceeded the 1.5 $\mu g/m^3$ National Ambient Air Quality Standard (NAAQS) for lead during this period. The highest quarterly average recorded was 7.3 $\mu g/m^3$ during the final months of 1981 with a 1981 yearly average of 3.03 $\mu g/m^3$. Because of persistent air standard violations, Taracorp was denied a permit by the Illinois Environmental Protection Agency (IEPA) to operate the smelter in 1983. Since the smelter ceased operations, air lead levels have remained well below NAAQS standard.

Ground water and dust samples

Ground water contamination by lead and other inorganics directly under the site has occurred. However, this water is not used for drinking water. No information was available on concentrations of lead or cadmium in house dust.

Human exposure

In 1982 and in 1983, the IDPH determined blood lead levels in 99 individuals of 43 households within 3.2 km of the lead smelter. This group included 47 children under the age of 6. The mean blood lead level of these children at that time was 0.64 $\mu mol/L$ (13.2 $\mu g/dl$) and a range of 0.05-1.79 $\mu mol/L$ (1-37 $\mu g/dl$). Similar blood lead levels were found in 31 children in Venice, an adjacent town in 1983. The mean blood lead levels for children of that age in the United States at the time was about 0.73

μmol/L (15 μg/dl). The IDPH, together with ATSDR, completed a health assessment on the Taracorp site in 1991. It was concluded based on the extent of lead contamination and possible human exposure that a potential health risk existed. This finding along with citizen concerns prompted the present exposure study.

METHODS

Rationale for study design

For this cross-sectional study, the primary hypothesis to be tested was ~~that~~ if lead in soil contributed significantly to blood lead levels in children. It was postulated that if soil lead was an important source of lead exposure, participants living farther away from the smelter where soil lead levels were presumed to be lower, would be less likely to have elevated blood lead levels than those living closer.

Although other age groups were included in the study, the major focus of the study was on children ages 6 through 71 months that had lived for at least 3 months at their present address. After a child has lived in an environment for about 90 days the blood lead levels should reflect the current exposure following a summer of outdoor play. Since young children are more susceptible to the effects of lead, and are more likely to be exposed, the sampling strategy for selecting study participants intentionally over-sampled this group. Other eligible residents, ages 6 through 45 years, were included from the target and comparison areas in smaller numbers and some older persons were included as well.

Selection of the target and comparison area

In 1991, the area of the NPL site and proposed cleanup area extended 0.8 kilometer (km) from the smelter. Following a site visit and a census, participants were recruited from within and from outside this area in concentric rings extending for another 3.2 km. No suitable comparison group that was not a continuum of the area proposed for cleanup area by USEPA could be identified. An attempt was made to include another residential area, Pontoon Beach, however, the houses there were built in the last three decades or represented trailer parks of recent vintage. Resident interest in participating in the study was also low. Within a reasonable distance from the study site, no other small-to-medium sized towns could be identified with a housing stock of similar age and a population of similar socioeconomic status as the study area.

It was, therefore, decided to recruit study participants from areas of Granite City, Madison, and Venice with similar housing stock but differing in proximity to the defunct lead smelter. Since no separate control group was available, hypothesis testing comparisons in the Illinois part of the study will primarily consist of regression analyses. There was no distinct physical separation between the children living closer and further away from the smelter. By using regression analysis, the functional relationship between the different variables of lead in paint, dust, soil and blood lead was examined taking socioeconomic, behavioral and other factors into account as well. However, dichotomous analyses of the data are also performed by dividing the population into two groups using soil lead concentration greater than or equal to (≥) 500 ppm (500 mg/kg) and less than (<) than 500 ppm (500 mg/kg) as cut-off points.

Making such comparisons reduces the sensitivity of the study, and may introduce a bias since other relevant risk factors in the study population vary with soil lead concentration and distance from the defunct smelter. Regression analyses is, therefore, the more appropriate approach.

NEED A MAP SHOW AREA

<u>Phase I: Census survey and enrollment of participants</u>

In the summer of 1991, a census of part of Granite City, and all of the two adjacent towns of Venice and Madison was conducted by the IDPH. Four residential sampling areas were defined based on earlier IEPA data. These data suggested that the soil lead concentrations decreased with distance from the smelter. It was presumed that sampling area 1, closest to the smelter, had the highest soil lead concentrations. This was the area placed on the NPL by the USEPA. Sampling area 2 was presumed to have soil lead concentrations ranging from slightly above to slightly below 500 mg/kg (ppm), while the soil lead concentrations in sampling areas 3 and 4 were lower (i.e. approximately background which may range from non-detectable levels to 200 mg/kg (ppm)).

The initial definition of sampling areas was somewhat arbitrary. Knowledge of exact soil lead concentrations in the 4 sampling areas was not necessary for the purpose of sample selection. The objective was to achieve a fairly representative range and distribution of soil lead values in the final study sample. Exact soil lead data were collected in the course of the study, and these data would replace the initial sampling area designations in most analyses.

A copy of the census form is attached (Attachment 1). The IDPH trained the interviewers and conducted the census. The census takers went from house to house interviewing the head of household or a knowledgeable adult surrogate. The census data were grouped into city blocks and the blocks were grouped into sampling areas. Sampling area 1 occupied the smallest geographic area. Some houses in sampling area 2 were still in the USEPA cleanup area while the houses in sampling area 3 and 4 were entirely outside the cleanup area. Age, gender, and length of residence was recorded for all individuals within each household. A 90-day residency was required for participating in the second phase of the study. This requirement insured that the children had spent the summer at their present residence and had time to build up blood lead levels reflective of their environment. The second phase consisted of collecting household and personal interview data, blood and urine specimens, and environmental samples.

<u>Phase II: Interviews</u>

Based on the information obtained in the census (phase I), all families with children under the age of six in the census area were contacted in the latter part of August and during the month of September 1991 and invited to participate in the study. The household identification number of the census was retained and used for the household questionnaire and the environmental samples. In addition, each participant received an identification number that was linked to the household identification number. All females listed as pregnant on the census forms were invited into the study if they had not given birth in the interim. A number of families participated because the age of their children was entered erroneously on the census form or one of their children had recently had a birthday and was now six years old or older. Some families with children under six requested that all children be tested. Thus, in the selection of the study population the age of the children was a controlling factor. Most older children and adults participated because a member of their family was less than six years of age. However, there were 33 families without a child under 6 years of age. One of these families was chosen because of pregnancy. For other families, the index case's date of birth had been recorded wrong on the census form and the child was not yet 6 months old or older than 6 years.

Appointments were made and the participants were asked to come to a centrally located office, where the interviews were conducted. The parents or guardians were asked to sign a consent form approved by a human studies review board (Attachment 2). A questionnaire (Attachment 3) was administered by trained interviewers. Minors old enough to sign their name were also asked to sign the consent form and the contents of the consent form was explained to all participants. The participants were informed that all identifying information would be kept confidential and that personal identifiers would be removed prior to publication of the data or submitting the data to any government agency. Permission was also obtained at this time for the collection of environmental samples at a later date.

Questions were asked about the household, occupation, hobbies, income and education of the parents, behavior of the children, and all potential exposures to lead. The questionnaire consisted of two parts, one dealing with the household and one with the participant. Some questions in the household questionnaire (e.g. those concerning occupations and hobbies) had fewer than ten affirmative responses. Many of these questions dealt with mining activities. These questions were not relevant for the study in Illinois. They were part of the questionnaire since the same questionnaire was also used for studies at mining sites. Infrequent affirmative responses were not used in the statistical analyses. However, they were occasionally of importance in the evaluation of possible reasons for elevated blood lead levels. The questions concerning time spent in different locations was transformed to create a single variable expressing the average time spent at home. The participant questionnaires were separated by age: 6 to 71 months, 6 to 14 years and 15 years and over. DEFINE

Phase III : Biological specimens

Following the interview, the participants donated a venous blood and a urine specimen at St. Elizabeth Medical Center. Specimens were obtained by trained pediatric phlebotomists. Urine was either collected in 250 ml sterile collection cups or in 150 ml sterile collection bags for children not yet toilet trained. Details of the collection of specimens, handling of specimens and laboratory methods are reported by Midwest Research Institute (MRI) (Attachment 4).

Laboratory methods and quality control

Clinical laboratory analyses of biomedical tests (blood and urine specimens) included the measurements reported in Table 1. These tests were either performed by the Centers for Disease Control and Prevention (CDC) in Atlanta, GA, St. Elizabeth Medical Center in Granite City, or the LaRoche laboratories in Kansas City, MO. The transport and handling of specimens was supervised by MRI and CDC. The blood was analyzed for lead at CDC using a published method (Miller et al., 1987). This method has a limit of detection of 0.03 μmol/L (0.6 μg/dl). Additional venous blood specimens were collected four months and one year later from children with an initial blood lead level greater than 0.48 μmol/L (10 μg/dl) and analyzed for lead at CDC.

The Complete Blood Counts (CBCs) were performed at St. Elizabeth Medical Center. The other clinical laboratory tests were either performed by LaRoche laboratories or by CDC. The sample collection and the data management was supervised by MRI and by CDC (Attachment 4). Urine samples were analyzed for cadmium according to the method reported by Pruszkowska et al. (1983) with a limit of detection of 0.1 μg/L. In addition to analyzing the samples from the participants, duplicate samples and quality control samples were also analyzed. This is described in detail by MRI in Attachment 4.

Environmental Samples

Soil, house dust, and drinking water were collected by a contractor of the USEPA-Region V (Chicago). In-situ paint analyses were performed on indoor paint using X-ray fluorescence (XRF) by an experienced lead paint inspector on contract to USEPA. A copy of the EPA sampling protocol is appended (Attachment 5). Up to eighteen readings were taken in three frequently occupied rooms from walls and wood work. Up to twelve exterior readings were also made. The XK-3 XRF instruments used in this study lose their sensitivity at lead paint concentrations above 10 mg/cm^2. At these higher concentrations, the amount of lead in paint above 10 mg/cm^2 was estimated by using the average weekly calibration time to get a 10 mg/cm^2 reading and by dividing the test reading (i.e. 10) by the ratio of the time to obtain a reading over the average calibration time. The condition of the paint where a reading was made was also rated. The condition code for the inside of the house was (1) intact, (2) slightly peeling, (3) moderately peeling, (4) extremely deteriorated. The measurements of the lead content of outdoor paint was subcontracted through the Illinois Department of Public Health and the Institute for Evaluating Health Risks with the same contractor used by USEPA-Region V, (Chicago) for interior paint readings. For the outside of the house, three conditions were used: good, fair and poor. Some imprecision in measuring lead levels in paint is unavoidable since levels at the higher end of the measurements had to be calculated and since surfaces and subsurfaces encountered in the field may affect the readings i.e. background scatter). Additionally, some of the houses had been re-sided, covering old lead paint underneath. These facts must be considered when interpreting the results. Ratings for the exterior condition of the house were missing for 59 houses or 15%. We assigned the mean building condition score of 1.389 to these houses to be able to use building condition in the regression analyses. Building condition missing values were not associated with any other variable and regression analyses including a missing value dummy variable showed that this procedure had no effect on the calculations.

DOES ANALYSIS DIFFER WHEN EXCLUD

The soil samples were analyzed by EPA method 6010 using inductively coupled argon plasma emission spectroscopy (ICAP). Both wet and dry soil lead levels and total solids were determined by the laboratory. Only the dry weight lead levels are reported here. Obvious paint chips were removed prior to soil analysis. A detailed description for the methods used to collect and analyze the environmental samples is appended (Attachment 5). Thirty-nine duplicate soil samples were also analyzed as a quality control measure.

Lead in dust was analyzed similar to the soil analysis (Attachment 5). The concentration of lead in house dust is not the best indicator of potential lead exposure because the size of the different areas that had to be vacuumed to obtain sufficient dust varied. A variable named "dust load" was calculated by dividing the dust sample weight by the surface area vacuumed and multiplying this ratio by the dust lead concentration. The "dust load" transformation used in this report combines the lead concentration and the amount of dust present in the house in one variable.

The concentration of lead in drinking water was determined in a first draw sample by graphite furnace atomic absorption. Cadmium similarly was determined in house dust and soil by ICAP emission spectroscopy and in water by graphite furnace atomic absorption. The limit of detection for lead in house dust was 20 ppm (mg/kg), for soil ≤20 mg/kg and for drinking water ≤2 ppb (µg/L). The limit of detection for cadmium in house dust was 2 ppm (mg/kg), soil 1.0 ppm (mg/kg), and for drinking water ≤0.5 ppb (µg/L).

<u>Reporting of results to participants</u>

The participants were informed of their individual clinical and environmental results by letter. The results of the clinical tests were presented at a public meeting in the Spring of 1992 without revealing the identity of the participants to reassure residents and encourage parents of untested children to have them tested. All families with at least one child with a blood lead level of 0.48 µmol/L (10 µg/dl) or above were visited, and potential sources of lead in the immediate environment of the child were identified for the guardians. The guardians were also instructed in nutrition, in personal hygiene of the children, and in reducing exposure through housekeeping and minor remediation of trouble spots in or outside of the homes.

Data entry and transformation

The census forms were key entered into ASCII files under the supervision of IEHR and were manipulated by two microcomputer data- base management programs dBase IV and BMDP-EM Data Manager. The precoded questionnaire data were directly entered into electronic data files. Key data points were entered twice to assure accuracy. WHICH WERE WHAT?

The clinical laboratory data were supplied electronically and in paper form by the different laboratories performing the analyses. The environmental data were supplied electronically and in paper form by the USEPA contractor and by the IDPH contractor. For values below the limit of detection, half of the value of the limit of detection was used. For the XRF readings, the value 0.001 mg/cm^2 was used for zero readings on walls without painted surfaces. This was done to assure that no cases were dropped during the calculations since in SAS the log of 0 is treated as missing. The assignment of the low number is similar to assigning one half the limit of detection. This number did not affect the analysis, however, it made it possible to use all available data.

The XRF data for five houses, lead levels in dust for six samples and lead levels in drinking water for four samples are missing because permission was not granted by some participants for the EPA collection team to enter their homes. In addition, the rating of the outside condition of the houses is missing for 15% of them. The missing data appeared to be random and no significant association was found between missing building condition and any other variable.

Since intact paint is less likely to result in exposure, we transformed the XRF reading by multiplying each paint XRF reading by its surface condition. The sum of all indoor paint conditions multiplied by the XRF readings for a house was divided by the number of measures taken to yield an average condition times XRF for each house. The same transformation was performed for the outdoor XRF readings. The transformed XRF variables produced modest improvements in correlations with blood lead.

The distance and direction of each house from the defunct smelter was estimated by mapping the houses and measuring the map distance with a ruler. These distances are only approximate.

Statistical analyses

Statistical analyses were done using the Statistical Analysis System (SAS) for the microcomputer. Univariate (descriptive) statistics were run on all variables. Only summary statistics (means, medians, and ranges) will be reported. Distributions of the biological and environmental data were positively skewed. Log transformation of these data resulted in more normal distribution. Where log-transformations were performed, the geometric means of these variables are also reported.

Variable selection

Simple bivariate Pearson correlations, analysis of variance, t-tests, and Chi-square analyses (with high/low blood lead grouping of subjects under six years of age) were inspected to eliminate additional variables that did not appear to be associated with blood lead. However, some variables (e.g. water lead) that could have been eliminated at this stage were retained based upon *a priori* hypotheses that all of the environmental samples would contain some lead and would have some impact on blood lead levels.

Bivariate analyses are presented for many combinations of variables. Blood lead values equal to or greater than 0.48 μmol/L (10 μg/dl) were used to define the high blood lead group among children under 6 for group comparisons and the more important predictor variables. The composite soil data were used to compare the group living in areas with soil lead levels of less than (<) 500 ppm (mg/kg) to a group living in areas where the soil lead levels (were greater than or equal to) (≥) 500 ppm (mg/kg) of lead in soil. This type of comparison, a dichotomous analysis, divides the continuous data into 2 parts based on a *priori* hypotheses such as comparing children under 6 with blood lead levels below and above 0.48 μmol/L (10 μg/dl), or children under 6 living in houses with concentrations of lead in composite soil samples of below (<) and above or equal (≥) to 500 ppm (mg/kg).

Multiple regression/correlation modeling (Cohen and Cohen 1975) which produces a set of multiple correlation coefficients was conducted for three purposes. First, multiple regression was used to help identify variables that had some utility for predicting blood lead levels in this population. Second, a maximum regression coefficient R^2 improvement analyses was conducted to identify the set of variables with the greatest predictive utility. Finally, hierarchical regression modeling was conducted to evaluate the contribution of soil lead to blood lead and house dust lead. Hierarchial regression modeling involves the sequential addition of variables to a multiple regression equation. At each step in the sequence a set of one or more variables is entered to those already entered and a standard regression equation is derived. The increment in R^2 represents the independent contribution of the last set of variables to the total variance accounted for by the regression model at that point. Hierarchical regression provides a means of testing the significance of a relationship while controlling statistically for the effects of other variables that could confound or modify the relationship.

Controlling for variables such as age, sex, and socioeconomic status (SES) may "over-adjust" the relationship with blood lead and other key variables in the regression analysis. Therefore, only a very small set of predictor variables was analyzed through hierarchical regression.

WHICH WERE?

Any IDEA AS TO ...

Participation rates

Census

The census resulted in the collection of 5,734 household census forms. Census workers were unable to interview anyone at 600 addresses (10.5%). Some of theses addresses were believed to be vacant houses and apartments, but no definite occupancy determination could be made. There were 5,134 usable census forms.

Based on responses contained in the census questionnaire, 906 (17.6%) households met the initial qualification criterion for participation in the study. One or more children under 6 years of age had lived in that dwelling for at least three months. After completing initial phone calls or screening visits, if the home lacked a phone, 116 households were disqualified for a number of reasons, the most common of which were: (1) the family had moved since the census, or they were away on vacation; (2) all of the children were younger than 6 months or older than 6 years; (3) the family had lived at their present address for less than 3 months; (4) the child under 6 either no longer lived there, or had not yet lived there for 3 months.

Residents of the neighboring community of Pontoon Beach were included in the initial census as they were considered as a possible second group of study control subjects adjacent to the eastern border of Granite City and about 7.2 km removed from the defunct smelter. However, Pontoon Beach was dropped from the final study target population because there appeared to be only 26 Pontoon Beach families in the census who qualified for selection and because the houses were newer or the children resided in a trailer park. This resulted in a final "nominal" target population of 790 households. This number includes households where, subsequent to administering the census questionnaire, no further contact was made.

<u>Exposure interviews</u>

Of the 790 target households, 355 (45%) participated in the study. Another 33 participating families (not counted in the 45% participation rate) lived in the target area, but they did not have a child under six years of age. This situation most often resulted when the youngest child in the family had aged into the next older age group by the time the family entered the study, when the child was no longer living at home, or when a child under six refused to give blood, or blood could not be collected, but other family members still wanted to participate. Since none of the children from those 33 households were less than six, the data for that group of households are not used in the main analyses discussed in this report.

A total of 266 (34%) households refused to participate. Many reasons were given for refusal. Most of the families that refused stated that they did not want to subject their child to the study's blood sampling procedure. (10) Some of the adults contacted expressed hostility or distrust, in some cases confusing our study activities with the EPA cleanup.

Another 169 (21%) target households listed in the census could not be contacted, or were schedules but missed appointments. Many of those who missed appointments were unable to come in for seemingly valid reasons (sickness, vacation, work schedule conflicts), while some were rescheduled many times and may have been "passive" refusals. Most of households in this group were difficult to contact. Of the 790 target households with young children, 30% had no telephone number on the census form, making follow-up contacts difficult even though the house was visited several times. Study qualification, participation, and refusal rates are presented in Table 2.

<u>Participation by sampling regions</u>

The target population for this study was geographically divided into four sampling areas. The areas can approximately be described as four concentric circles, as in a target, with the Taracorp site at the bull's-eye. These sampling regions were intended to roughly reflect a gradient in *a priori* estimates of soil lead levels. The sampling areas were of unequal size, with sampling area 1 (closest to Taracorp) containing the smallest number of houses. When the study was done in 1991, this area represented the potential cleanup area. It extended roughly 0.8 - 1.0 km out in all directions from the Taracorp boundary. Sampling areas 2 and 3 were each roughly 0.8 - 1.0 km in width, and area 4 was roughly 1.2 km in width.

Participation by sampling areas is presented in Table 3. Participation rates were similar for each sampling area, with a slightly lower rate of participation in area 4, the region farthest from Taracorp. Denominators for the rates in Table 3 include all 790 target households identified in the census.

The participants lived in 388 separate households. Occasionally more than 1 family shared a household. There were 230 families with 1 child under 6, 106 families with 2 children under the age of 6, and 14 families with 3 or more children under the age of 6. In some of the larger families not all children had the same parents. A total of 212 youth ages 6-14 were included in the study from 107 households. Of these, 56 households had 1 youth and 51 had 2 or more resulting in an average number of youths (ages 6-14) per household of 1.98. A total of 123 teenagers and adults also participated in the study. These individuals came from 87 households, with 51 households supplying only 1 adult. There were 101 non-white children in our study population. Of these, 87% were of African-American decent.

Participant characteristics

The participant characteristics differed by sampling area. Overall, 17% of the heads of household had not finished high school, 45% graduated from high school, and 38% had advanced education. The educational level achieved by the parents of the children under 6 years of age with blood lead levels above and below 0.48 μmol/L (10 μg/dl), differed significantly ($p<0.001$). Among the heads of household whose children had blood lead levels above 0.48 μmol/L (10 μg/dl), 35% had not finished high school, 42% had a high school diploma, and 23% had some higher education. For the heads of household with children with blood lead levels below 10 μg/dl (0.48 μmol/L), 14% had not finished high school, 46% had a high school diploma, and 40% had higher education. Fifty-eight percent of the heads of household with children under 6 with blood lead levels above 0.48 μmol/L (10 μg/dl) had incomes of less than $15,000 per year. Only 41% of parents with children whose blood lead levels were below 0.48 μmol/L (10 μg/dl) were in this group. In the income bracket of $15,000-25,000, 24% had children with blood lead levels above 0.48 μmol/L (10 μg/dl) and for 22% blood lead levels were below 0.48 μmol/L (10 μg/dl). At income levels of $25,000 or above, 37% had children with blood lead levels below 0.48 μmol/L (10 μg/dl) while 18% had children with blood lead levels above 0.48 μmol/L (10 μg/dl). This was statistically significantly different ($p<0.01$). As income increased, the chance that a child in the family had an elevated blood lead level decreased, however, education was a better predictor of blood lead levels than income.

At least 1 smoker was present in 263 or 68% of the households. In 5% of the households 6 or more smokers were present. The mean number of cigarettes smoked per household per day was 16 with a range of 0-88. A total of 341 or 87.8% of the 388 households had air conditioning.

In households with air conditioning, the average number of cigarettes smoked per day was 17.6, and, in houses without air

- Use of summary sheets to document collection of specimens and generation of QC specimens each day.

Examples of all documentation forms are given in Appendix B.

5.3.2 Controls

The on-site personnel generated quality control specimens for the biomedical tests and routine blood and urine tests. "Blind" controls were obtained from Baxter Scientific Products as follows:

- Biomedical Tests—Dade® Moni-Trol® blood chemistry controls, lyophilized, assayed serums in the normal and abnormal ranges were used. (Lot Nos. LTS-29, PTS-118, and PTS-117).

- Urinalysis—Hycor Biomedical KOVA-trol® human urine controls in the normal, high abnormal, and low abnormal ranges were used. (Lot Nos. 17192, 17920, and 30490).

- CBC—S/P® Brand Diff-Trol® 8 Plus hematology controls in the normal, high abnormal, and low abnormal ranges were used. (Lot Nos. BWT-172, BWT-173, and BWT-174).

A procedure for preparing the control specimens was written, used in training, and maintained on-site for reference. The procedure is included in Appendix D.

The blind controls were included at the rate of 15% of field specimens submitted to Roche and the local hospital laboratories for analysis.

5.3.3 Replicates

Blind replicates were prepared at the rate of 10% of field specimens and were submitted to Roche and the local hospital laboratories for analysis. Urine specimens of sufficient volume were split to provide UA replicates, and extra tubes of blood were drawn from older participants to provide CBC and blood chemistry replicates.

A procedure for preparing the replicate specimens was written, used in training, and maintained on-site for reference. The procedure is included in Appendix D.

5.3.4 Blanks

Field blanks for urine cadmium were prepared daily using water prescreened by CDC/CEHIC. The procedure for preparing the blanks is included in the CDC/CEHIC Protocol (Appendix A) and in Appendix D. The field blanks were transported with the urine cadmium specimens to CDC/CEHIC for analysis.

5.3.5 Review of Participant's Test Results

Each individual participant's test results received in hard copy at MRI from Roche and the local hospital laboratories (blood chemistry, CBC, and UA) were reviewed for abnormal results by MRI staff. Abnormal results were reported to a designated person at each site by telephone, and hard copies of the results were subsequently mailed.

III. ENVIRONMENTAL SAMPLE COLLECTION

Preparation for the environmental sample collection begins at the field office. The environmental team will be given an assignment for the morning or the entire day. Once the assignment is received, the environmental team members will check the accuracy and completeness of the data on each environmental sample form. The Dwelling ID Number and other identifying information should be on all the environmental forms.

The environmental team will then calibrate the Paint XRF instruments (Princeton Gamma-Tech XK-2 or XK-3). Both the Princeton Gamma-Tech XK-2 and the XK-3 instruments will be used. Both instruments operate on the same principle. The newer model, the XK-3 is capable of reading only to a maximum of 10 mg Pb/sq.cm. Paint in the older housing may have higher concentrations of lead, thus, when monitoring teams visit older housing, i.e., those built before 1940, the XK-2 should be used.

After the necessary calibration of equipment, the environmental monitoring team should make certain that all equipment and supplies are ready for use (see checklist).

All members of the team should wear appropriate identification. All members should be introduced to the residents along with a short explanation of the monitoring process (see Attachment).

Exterior and interior samples will be collected. The interior samples and information to be collected is as follows:

1) Collection of tap water samples.
2) Sketching a floor plan of the residence.
3) Collection of interior surface dust samples.
4) Water system evaluation.
5) Screening for lead in painted surfaces; walls and trim, avoiding metal doors outlets, etc.
6) Collection of soil samples.

1. INTERIOR SURFACE DUST

Interior surface dust is collected by using a Hoover brush vacuum cleaner 1/3 HP, 2 Amp motor S-1083-100. At each collection a coffee filter will be fitted into the dust collection area.

The interior surface dust sample will consist of a composite of at least three sub-samples taken from the following areas in the residence:

1) An area adjacent to the main entrance.
2) A floor area in the room most-utilized by the subject child.
3) A floor area in the child's bedroom.

Additional sub-samples should be added to the composite sample, for example, from window sills which are accessible to children.

The main entry sample is collected from the floor close to the entry door. The entry mostly used by the family should be used. The identification of sample sites from the most frequently occupied room and the child's bedroom will be determined partly by the floor covering present in those rooms. If the floor is carpeted, an adequate sample can readily be collected from almost any pathway in the room. A pathway might consist of an area immediately inside of a doorway into the room or an obvious pathway from one side of the room to the other. In rooms where there is no carpeting, the most likely place to find an adequate supply of surface dust would be an area immediately adjacent to a wall. For each floor surface a one meter square area should be vacuumed.

The dust sample is collected by vacuuming the area three times. The first collection should cover the entire area completely, vacuuming back and forth in one direction. The collector should then turn 90 degrees and vacuum the entire area once again. Finally, the third collection should be taken from the original position.

As each sub-sample is collected, its location should be indicated on the floor plan which was completed earlier. Care should be taken to note the total number of the areas sampled. At the completion of the sample collection, the coffee filter will be removed from the collection device, folded and secured in a sample container. The dwelling ID number and the sample number should be written on the side of the filter paper and the outside label of the container.

2. WATER SAMPLE COLLECTION

To be added later

3. LEAD PAINT SCREENING

The first step in the survey of lead paint in the residence is the calibration check of the instrument. For both instruments it is necessary to make calibration readings prior to taking any readings in the residence and to record those calibration readings on the paint survey form. Three separate readings will be made on the standards provided with the instruments. For calibrating the XK-2, readings should be taken with the high-lead standard, the zero-lead standard, and the 2.99 mg Pb/sq cm paint standard. The XK-3 is checked by using the zero-lead and the 1.50 mg Pb/sq cm standards. All calibration information should be added to the FORM 07 XRF Lead Paint Screening work sheet.

Two surfaces, painted woodwork and walls, in three separate rooms of the residence will be evaluated. Unpainted surfaces, such as paneling, wallpaper and unpainted woodwork will not be screened.

The three most frequently occupied rooms or areas of the residence will be screened. These areas will very likely be the living room or family room, the kitchen, and the subject child's bedroom. If these rooms are unpainted, then other alternative rooms will be selected.

In order to characterize the paint and surfaces in a given room, at least one painted wall and one painted trim in the room (door or window sill) should be screened. When screening the woodwork, three separate readings will be taken at three different locations on the woodwork. A similar procedure will be used for screening painted walls within a room. One reading will be taken on each of three separate wall areas, either on the same wall or on different walls within a room. If all walls are painted the same color, then the three readings can be taken from one wall. If the walls are painted different colors, then a reading from the different colored walls should be included. The mean of the three readings should be recorded for each room.

At the completion of the interior paint screening, the exterior painted surfaces should be screened. Three separate areas on the outside of the structure should be screened for lead. As with the interior screening, unpainted surfaces should not be considered. The selection of areas to be screened should be based upon: (1) apparent differences in the color and/or age of paint, (2) the apparent condition of the paint, (3) differences in surfaces, for example, painted walls vs. trim. The locations of all paint XRF readings should be noted on the sketches completed by the monitoring team or teams. All XRF readings should be recorded on the forms entitled lead paint screening.

In addition to the paint lead screening, the environmental monitors will make an evaluation of the condition of painted surfaces. This evaluation will be a rating scale of 1 to 4:

1) Intact
2) Slightly Peeling
3) Moderate Peeling
4) Extremely Deteriorated

4. SOIL SAMPLING

To be added later

APPENDIX A: FIELD SAMPLING PROTOCOLS

Note: In the event of inconsistencies between the following protocols and the QAPP, the protocols shall govern.

Preparation for the environment sample collection begins at the field office. The environmental team will be given an assignment for the morning or the entire day. Once the assignment is received, the environmental team members will check the accuracy and completeness of the data on each environmental sample form. The Dwelling ID Number and other identifying information should be on all the environmental forms.

The environmental team will then calibrate the Paint XRF instruments (Princeton Gamma-Tech XK-2 or XK-3). Either the Princeton Gamma-Tech XK-2 or the XK-3 instruments, or both, will be used. Both instruments operate on the same principle. The newer model, the XK-3 is capable of reading only to a maximum of 10 mg Pb/sq. cm. Paint in the older housing may have higher concentrations of lead, thus, when monitoring teams visit older housing, i.e., those built before 1940, the XK-2 should be used, if available. If the XK-2 is not available, an attempt should be made to extrapolate values greater than 10 mg Pb/sq.cm. with the XK-3.

After the necessary calibration of equipment, the environmental monitoring team should make certain that all equipment and supplies are ready for use.

All members of the team should wear appropriate identification.

Exterior and interior samples will be collected. Exterior samples to be collected are soil samples. The interior samples and information to be collected is as follows:

1) Collection of tap water samples.
2) Sketching a floor plan of the residence.
3) Collection of interior surface dust samples.
4) Screening for lead in painted surfaces; walls and trim, avoiding metal doors outlets, etc.

I. Soil Sample Collection

The Primary method of determining the lead content of the soil will be by acid digestion and graphite furnace atomic absorption spectrometry.

A. Site Description

For each location, a detailed drawing should be made that shows the boundary of the lot, the position of the main building and any other buildings such as storage sheds or garages, the position of the sidewalks, driveways, and other paved areas, the position of the play areas if obvious, and the position of the areas with exposed soil (grassy or bare), roof rain spouts and general drainage patterns.

In addition to the diagram, briefly describe the location, including the following information:

- Type of building construction (brick, wood, etc- 1 or 2 story)
- Condition of main building
- Condition of property (debris, standing water, vegetation cover)
- Presence and type of fence
- Animals on property
- Apparent use of yard (toys, sandbox, children present)
- Location of 10 soil aliquots

B. Sample Collection

Sample Collection shall be performed as outlined in the QAPP, with the exception that all aliquots will be of equal volume and will be mixed in a stainless steel bowl prior to packaging. Assemble composite soil core segments in 8 ounce glass jars suitable for prevention of contamination and loss of the sample. Record the sample identification number on the bag and the sample record sheet. Store the composite soil sample at ambient temperature until submitted to the laboratory for analysis.

Clean the corer after collecting each sample composite by reinsertion of the corer into the soil of the next sampling area.

C. Sample Handling and Storage

Seal the sample jars to prevent loss or contamination of the sample and store samples in a dry location at ambient temperature.

Record-keeping and Sample Custody: Initiate soil sample records for each location. Record sample numbers on location diagram, soil area description, and sample record sheet. Send the sample to the laboratory and release the sample to the laboratory personnel for analysis.

II. Surface Dust Collection

A. Sample Collection

A portable "dustbuster" type vacuum cleaner will be used; due to the sample size required, the Sirchee-Splittler modified dustbuster will not be used. Use a new bag for each household, to avoid cross-contamination. In order to ensure that the sample size is sufficient, either weigh the sample using a field scale or collect a large enough sample to ensure that three to five grams of dust have been collected.

B. Sample Areas

The interior surface dust sample will consist of a composite of sub-samples taken from the following areas in the residence:

Entry (E): A floor area inside the residence directly adjacent to the main entry to the residence.

Floor (F): At least 3 floor areas which should include but are not limited to a sample from a high-traffic area in the main living area and a sample from the child's bedroom. If carpet is present in the residence it shall be the first choice of sample area. If carpet is not present, a mixture of non-carpet floor areas will be sampled.

Window (W): At least three window areas (window sills and window wells), including but not limited to a window in the main living area and a window in the child's bedroom.

The main entry sample is collected from the floor close to the entry door. The entry mostly used by the family should be used. The identification of sample sites from the most frequently occupied room and the child's bedroom will be determined partly by the floor covering present in those rooms. If the floor is carpeted, a larger sample can readily be collected from almost any pathway in the room. A pathway might consist of an area immediately inside of a doorway into the room or an obvious pathway from one side of the room to the other. In rooms where there is no carpeting, the most likely place to find an adequate supply of surface dust would be an area immediately adjacent to a wall. For each floor surface, an approximately one meter square area should be vacuumed. Additional living areas (e.g. additional floor areas, around furniture, etc.) Should be vacuumed, if necessary, to obtain an adequate sample size. In no event shall dust be obtained from household areas where dust generally collects for long periods of time, such as behind major appliances, under beds, etc.

The sample sequence should be as follows: collect the bedroom, kitchen and living room samples first. Then, collect the floor sample from the entry way. Then, collect the window well samples. ~~Finally~~, if necessary~~,~~ collect the samples ~~from~~ additional living areas.

C. Sketch of Residence

In order to more fully describe where samples have been collected, a top view of the residence will be made by the sampling crew. This sketch should show the primary features of the residence, including a north arrow indicator and the relationship of the various rooms to each other. The sampling areas should also be indicated. Rooms should be labeled according to their apparent function.

III. Water Sampling

Residents will be provided with clean, capped bottles and instructed to collect water on the day of scheduled environmental sampling. The sampling team or its manager should give the following instructions to the resident who will collect the sample:

The tap water sample should be taken from the cold water faucet of the kitchen. It should be a first flush sample of water that has been standing in the pipes from 6 to 18 hours. There are two options for the time a sample is taken: (1) it can be taken first thing in the morning, or (2) if all of the residents of the household have been out of the house for the entire day, it can be taken at the end of the day (i.e. dinner time). Labelled plastic bottles will be provided for the sample. The bottle should be completely filled with water. The sampling team will pick up the sample at a convenient time on the day of scheduled environmental sampling.

Before dropping off a water collection bottle, the appropriate member of the sampling team will fill out and affix the label provided. The chain of custody form will be initiated when the collectors pick up the water sample. Region V will record pH and conductivity prior to acidifing the sample.

At the end of each collection day, water samples will be acidified with nitric acid, per required protocol. After the addition of the nitric acid to the water sample, the initials of the person adding the acid to the sample and the time and date will be recorded. In no event will the nitric acid preservative be provided to the residents.

WATER SYSTEM EVALUATION

An evaluation will be made of the plumbing under the kitchen sink in order to determine the composition of water lines servicing the kitchen sink. The water supply beneath the kitchen sink generally consists of hot and cold water pipes coming from either the wall behind the sink or, occasionally, up through the floor into the cabinet beneath the sink. These supply lines generally terminate at shut-off valves beneath the sink. The supply lines continuing from the shut-off valves are generally of different material than the supply lines going to the shut-off valves.

Supply lines in residential construction can be copper, galvanized, PVC, or lead pipe. PVC pipe is easily identified because of its plastic composition. Copper pipe can be identified by scraping the surface corrosion from the pipe to reveal the bright copper color. Galvanized pipe can be recognized by the threaded fittings if present and visible or by the hard surface of the pipe. Lead pipe can be recognized by the softness of the material. It is easily bent into shape and can be scratched with a knife blade or other hard tool. When scratched, the exposed surface is silvery in color.

The supply lines running from the shut-off valves to the sink generally are copper, chrome-plated brass or PVC. The PVC is easily recognized because of its plastic composition. Chrome-plated brass is also easily recognized because of the shiny surface. Copper can be identified by scratching the surface to reveal the copper color. Identifying the composition of the plumbing system beneath the sink completes the evaluation of the plumbing system. All information should be recorded.

IV. Paint Sampling Protocol Using an XRF Analyzer

A. Background and Selection of Surfaces

The concentration of lead in paint will be determined by using an X-ray fluorescence analyzer. Two types of instruments may be used, the XK-2 or the XK-3, both manufactured by Princeton Gamma-Tech, Inc. The XK-3 with a range of 0-10 mg of Pb per cm^2 will be the primary instrument used. If available the XK-2 will be a backup and also used in the event a reading on the XK-3 exceeds 10 mg/sq cm^2.

In each residence two surfaces, a painted woodwork and a painted walls in each of three rooms or areas most frequently occupied by the subject child will be evaluated (e.g. child's bedroom, kitchen, living room). One reading will be taken at three different locations on each type of surface. The identity of the rooms and the Pb found in the paint will be recorded. In addition, a copy of a floor plan of the

residence will be available to the technician and on which the sample location will be noted. All unpainted surfaces, such as paneling, wallpaper, and unpainted woodwork will not be tested. ~~In~~ the event a room selected is unpainted an alternate room will be selected and this information recorded.

In order to characterize the paint and surfaces in a given room at least one painted wall and one painted trim in the room (door or window sill) should be screened. When screening the woodwork, three separate readings will be taken at three different locations on the woodwork. A similar procedure will be used for screening painted walls within a room. One reading will be taken on each of three separate wall areas, either on the same wall or on different walls within a room. If all walls are painted the same color, then the three readings can be taken from one wall. If the walls are painted different colors, then a reading from the different colored walls should be included. Whenever changing areas or locations, one reading should be taken to clear the machine prior to taking the actual reading to be recorded. The arithmetic mean of the eighteen readings should be recorded as the reading for the house. Each individual reading will also be recorded to provide data for future follow-up actions, if necessary.

XRF readings will be taken by placing the instrument on the designated surface and opening the shutter. (More accurate readings can be obtained from flat surfaces so curved surfaces will be avoided). Once the shutter is opened the lead content of the paint will appear as a visual numerical display on the instrument. The operator will read the number for the other team member to record. This will be repeated back to the operator.

In addition to the paint lead screening, the environmental monitors will make an evaluation of the condition of painted surfaces. This evaluation will be a rating scale of 1 to 4:

1) Intact
2) Slightly Peeling
3) Moderate Peeling
4) Extremely Deteriorated

B. Operation of the XRF Analyzer to Determine the Concentration of Lead

At the start of each day the performance of the XRF instruments are evaluated using standard procedures. Prior to taking readings at the residence, calibration checks will occur using reference material prepared by the Department of Housing and Urban Development. After the designated areas in the home have been sampled and before the team is ready to leave, the instrument's calibration will once again be checked. All calibration information should be added to the FORM 07 XRF Lead Paint Screening work sheet, if available, or equivalent form.

Following is the Operating Procedure for the XK-3 unit:

1. Remove the battery pack, coiled cable, and XK-3 unit from the carrying case.

2. Connect the battery pack to the XK-3 unit, using the coiled cable.

3. Locate the LOCK SWITCH underneath the handle toward the rear of the unit and push it forward. A red light over the display window will now glow to indicate that the instrument is ready to perform its analysis as soon as the shutter is opened.

4. Depress the RED RESET button on the back plate of the unit, just above the coiled cable connection, and hold for 8-10 seconds.

5. Grasping the wooden handle, position the face-plate of the instrument against the surface to be measured and push down firmly and evenly on the handle to spring the shutter open. The red light over the window will now blink to indicate that the shutter is open and that the measurement is taking place. As soon as the shutter opens, the previous read-out in the window vanishes, leaving the window blank except for a single decimal point.

6. Keep the handle firmly depressed until the new read-out appears.

7. When the new read-out appears, release pressure on the handle. The display window retains read-out until the handle is pushed down again to begin another measurement.

8. Push the lock switch back to the lock position when readings are completed.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

DATE: 24 OCTOBER 1991

SUBJECT: SAS REQUESTS FOR THE NL INDUSTRIES TARACORP LEAD SMELT SITE, GRANITE CITY, IL K7

FROM: JAN PELS, RSCC JPels

TO: ELENOR MC LEAN, SMO SAS COORDINATOR

The sampler is E&E. The activity does not fit into a standard category; it is a Superfund non-enforcement ATSDR Multi-State Lead Exposure Study.

The samples have already been collected and will be shipped within one week of award of the SAS contracts. While the number of samples is large, the analysis is for two metals only. A single lab for each matrix type is preferred (one lab for the waters and one lab for the soils). Please keep me informed if during the solicitation this requirement becomes a problem.

There will be a total of 414 soil samples and 446 water samples for lead and chromium analysis using the two attached SAS requests. For each matrix, we will require a 14 day turnaround on approximately 40 samples each. These priority samples will be identified up front and will be sent as the first shipment. All remaining samples will then be shipped within a few days. Data for the remaining samples will be due within 42 days of VTSR. This will allow the lab to perform the sample analyses at a rate of approximately 100 samples per week for the remaining 4 weeks after submission of the priority sample data.

Note that for the water samples, the lab is required to FAX the RSCC or ship out via overnight mail the results for the first 10 samples. The Region will review the data within 2-3 days of receipt and will contact SMO to confirm that the analyses can proceed according to the specifications in Section 8 of the SAS with a lesser rate of analytical spikes.

Please call if you have any questions.

Thank you.

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, TSCA, etc.):

Superfund ATSDR Multi-Site Lead Exposure Study

4. Estimated date(s) of collection: September 4 - October 4, 1991

5. Estimate date(s) and method of shipment: ASAP after lab selection; Federal Express

6. Number of days analysis and data required after laboratory receipt of samples:

21 days after receipt of last sample in each SDG (20 samples) (21 days is negotiable for a SDG within the context of the entire project).

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

Samples and blanks will be acidified with 5.0 mL of 50% HNO_3 per liter to pH <2. Sampl will not be digested prior to analysis because of insignificant suspended solids content from a public water supply tap. If suspended solids are noted, they will be so indicated on traffic report, and lab will digest samples (per SOW 3/90) prior to analysis. Lab wil also shake samples prior to any analysis. Lab will also digest samples at its discretion if suspended solids are noted (for first 140 samples collected, observations are that non should require digestion).

All standards, blanks, and initial and continuing calibration verification standards will be matrixed-matched to the sample preservation (5.0 mL of 50% HNO_3 per liter).

Instrumental analysis will be Method 213.2 CLP-M* (Atomic Absorption, Furnace Technique) for Cd and Method 239.0 CLP-M* (Atomic Absorption, Furnace Technique) for Pb. Calibration range of each GFAA should cover the range of 0.1 or 0.2 to 2 or 4 ug/L for Cd Cd and 1 or 2 to 25 or 40 ug/L for Pb.

3. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.) (Cont.):

that the remaining samples will be analyzed using analytical spikes at a lesser frequency as described here.

After verification: it is expected that the samples of uniform matrix can be tested without an analytical spike for each sample. Analytical spikes are to be performed at a frequency of 1 in 5 or 1 in 10, with recoveries of 85 to 115%. If analytical spikes are outside of this range, all intervening samples are to be retested, or MSA is to be followed. Sample dilution is allowed for cadmium to achieve desired accuracy and still meet the required detection limit. Sample dilution is not allowed for lead to meet required accuracy. The decision of whether to use 1 in 10 or 1 in 5 analytical spikes will be made by the laboratory based on consequences for reanalysis and instrument instability.

QC requirements will be mandatory. Data are not to be qualified by the lab for spike/dup. problems (except for unusual samples) without prior approval of SMO and Region V.

Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of-Custody documentation, etc.). If not completed, format of results will be left to program discretion.

SOW 3/90 deliverables will be modified to allow for quantitation directly from the calibration curve. Any samples digested will follow SOW 3/90 and will require full GFAA "decision tree". Initial 10 to 20 Cd and Pb analysis will be performed according to full GFAA "decision tree" of SOW 3/90 and will be provided to SMO and Region V for review and acceptance of subsequent scheme for GFAA analyses. These initial analyses can be provided by fax or overnight mail for review, in order to minimize the amount of qualified data. with mandatory QC requirements for waters of uniform matrix.

IDLs are to be provided for each GFAA instrument (per SOW 3/90 protocols) and are to be less than 0.5 ug/L for cadmium and less than or equal to 2 ug/L for lead. All values greater than or equal to IDL are to be reported.

II. QC REQUIREMENTS (CONT.)

Audits Required	Frequency of Audits	Limits (Percent or Concentration)
Field blanks Note: Field personnel will clearly identify the field blanks.		If > 2 ug/L Pb or >0.5 ug/L Cd, contact SMO immediately for further instructions.
5. Lab Duplicates	1 in 10	±10% or ±0.3 ug/L for Cd or ±2 ug/L for Pb (mandatory reanalysis is necessary, if limits exceeded.

II. QC REQUIREMENTS (CONT.)

Audits Required	Frequency of Audits	Limits (Percent or Concentration)
6. Digested samples	SOW 3/90 GFAA protocols for both Cd and Pb	See SOW 3/90

Note: No prep blanks and matrix spikes are necessary for undigested samples.

. ACTION REQUIRED IF LIMITS ARE EXCEEDED

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for Special Analytical Services. Should you have any questions or need any assistance, please call the Sample Management Office.

7360:1

3. Purpose of analysis (specify whether Superfund (Remedial or Enforcement), RCRA, NPDES, etc.):

Superfund - ATSDR Multistate Lead Exposure Study

4. Estimated date(s) of collection: September 4 - October 4, 1991

5. Estimate date(s) and method of shipment: ASAP after lab selection: Federal Express

6. Number of days analysis and data required after laboratory receipt of samples:

21 days after receipt of last sample in each SDG of 20 samples (21 days is negotiable for a SDG within the context of the entire project).

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

Most samples are expected to be uniform soils of low moisture content after compositing. A ten gram sample aliquot will be selected for % solids test (103-105° C) and residue will be used for sample analysis. Residue will be broken up into free-flowing powder so that representative 1g sample aliquots can be selected, and the unused portion must be archived. Any heterogeneous soil samples will be homogenized prior to analysis, using an air-dried aliquot, and a SPEX 8000 Mixer/Mill (or equivalent). Laboratory has discretion to homogenize all soils prior to analysis. Samples will be digested using SOW 7/88 or ILM01. ICP calibration standards and sample digests will be matrix-matched (1g. of soil will be digested for 200 mL of final solution) as to acid contents. If microwave digestion of ILM01 SOW is used, standards, QC solutions, and digests must be matrix matched as to nitric acid concentration.

Sample digests will be tested for Cd and Pb using ICP emission spectroscopy of SOW 7/88 or ILM01, including solid Lab Control Standard, with extra QC criteria listed below. All elements necessary for interelemental corrections and dissolved solids interferences will be measured and reported in raw data. Only Cd and Pb will be reported on Form I for each soil sample.

QUALITY ASSURANCE PROJECT PLAN

FOR

EPA REGION V SUPPORT

OF THE ATSDR

MULTISTATE LEAD EXPOSURE STUDY

(ADOPTED FROM REGION VII QAPP)

I. Project Description

Granite City, Illinois is the location of a former secondary lead smelting facility. Metal refining, fabricating, and associated metal processing activities have been conducted at the site since 1903. From 1903 to 1983, secondary smelting occurred on-site. Secondary smelting facilities included a blast furnace, a rotary furnace, several lead melting kettles, a battery breaking operation, a natural gas-fired boiler, several baghouses, cyclones and an afterburner. Most (85 percent) of the air samples taken from Granite City between 1978 and 1981, as part of IEPA's newly instituted air quality testing for lead, showed lead levels higher than levels the federal government considers safe. Metallic pollutants, which have been dispersed throughout the environment in Granite City and the surrounding areas, have heavily contaminated soil in the study area. It is likely that uptake of metallic pollutants by plants and animals, including humans, has occurred. The Agency for Toxic Substances and Disease Registry (ATSDR) has provided funding to the State of Illinois to conduct a comprehensive blood lead/urinary cadmium study on a representative number and distribution of eligible residents nearby the site. The study will include the collection of samples from potential study will include the collection of samples from potential environmental sources of lead and cadmium: soil, house dust, drinking water and indoor paint, from all participant households.

The objectives of the overall study are defined in the ATSDR study protocol (Draft; Summer, 1991; pages 8 and 9). Of the seven objectives listed, the objectives to which EPA participation will contribute are:

> "To determine the level of environmental lead and cadmium contamination found in target areas and compare them with levels of contamination found in comparable non-target areas."
>
> "To determine the extent to which environmental, behavioral, occupational, and socio-economic factors influence exposure to lead and cadmium in target and non-target populations."
>
> "To determine the extent to which exposure has occurred in populations living in areas with both mining and industrial emissions compared to populations living in areas with industrial emission only."

In order to contribute to meeting these goals, EPA will collect environmental samples at the residences of selected study contractor, in accepting the assignment to support this Study, agrees to perform sampling activities as outlined in this Plan and in conformance with applicable Region V CLP protocol the attached Region VII Standard Operating Procedures (SOPs), and other guidance which may be provided by EPA for performance of Study-related activities.

D. Sample receipt, storage, handling, and custody within the laboratory will be the responsibility of the selected CLP laboratory.

E The selected CLP laboratory will receive and analyze the environmental samples and report analytical results to Region V representatives, following procedures outlined in this Plan and applicable Region VII SOPs referenced below.

F. Final data review and validation will be the responsibility of E&E, after normal review of the data during and after analysis by the analyst, supervisor, and data review or QA/QC personnel at the CLP lab.

G. Transmittal of reviewed and validated data on disk to U.S. EPA Region V will be the responsibility of E&E.

H. Transmittal of final data in a brief report to U.S. EPA Region V will be the responsibility of E&E.

I. Brad Bradley will be responsible for the dissemination of applicable environmental data to the appropriate entities in the State of Illinois, for responding to questions from the State, and for addressing public questions relating to the study from the Federal perspective.

J. ATSDR will assume final Federal responsibility for the Study data because of the greater protection of individual privacy afforded ATSDR data bases; EPA final data is subject to FOIA request actions. ATSDR will perform statistical review of the environmental data vis-a-vis human exposure data. All study data shall be made available to EPA upon request, for purposes such as evaluating the Pb uptake/biokinetic model.

K. Program and field sampling QA/QC oversight will be the responsibility of E&E.

These detection limits will permit evaluation of field sample data against the following limits, so as to determine whether the samples are above background levels with a 95% confidence level.

Sample Medium	Action Level Lead	Cadmium
House Dust	500 ug/g	136 ug/g
Paint	0.7 mg/sq.cm.	N/A
Drinking Water	15 ug/L	5 ug/L
Play Area Soil	500 ug/g	136 ug/g

Note the detection limits of one-tenth the action levels noted may not be achieved if the minimum sample amounts discussed in Section IV, Sampling Protocols, are not collected. Also, available analytical methods may not permit analysis of Cd in water at concentration as low as 0.5 ug/L. A detection limit of 2.0 ug/L will be acceptable for lead in water.

IV. Sampling Protocols

A. Environmental Sampling Design Considerations

1. Selection of Residences to be Sampled:

   a. In order to meet the Study goals outlined above, EPA Region V will collect environmental samples: soil, house dust, drinking water and paint, from all households in the Study area at which biological sampling is scheduled. In order to identify high biomedical metal levels, an action level of 10 ug/dL of Pb in blood and/or 8 ug/L Cd in urine will be used.

   b. Environmental sampling will be conducted at all households where biomedical testing occurred. The names, address, and telephone numbers of residences to be sampled shall be forwarded to EPA by IDPH as soon as practicable. EPA plans to perform environmental sampling in on sampling event which is scheduled to begin the first week of September, and will last approximately four weeks.

2. Sample Containers: Sample containers and associated supplies will be obtained by E&E and prepared and utilized per SOP 2130.4A, with the exception that one liter poly bottles will be used for the collection of water samples. In the event sample container and preservation information in this QAPJP contradicts any information in the attached SOP, this document shall have precedence.

3. Sample Collection Procedures:

Note: See the attached Appendix A, which shall supercede the language below in the event of any inconsistencies.

a. Drinking Water samples will be collected in accordance with SOP 2334.10A, with the following exception: all samples of drinking water will be first-draw samples, as specified in the EPA's Final Rule for Lead and Copper in Drinking Water, Federal Register, June 7, 1991. These samples may be collected by the residents in sample containers with appropriate preservatives, supplied by E&E in advance, and picked up at the time of the dust, soil and paint sampling. Alternatively, E&E may chose to send a sampler first thing in the morning to all residences to be environmentally sampled that day to draw the samples, after pre-arranging with the residents so that the water is not turned on prior to sampling. Either method is acceptable, but the method chosen must be applied consistently to all residences sampled during the project, and the choice of method must be documented in writing by E&E in the final project report.

One field blank (deionized water) will be submitted blind for laboratory analysis at a frequency of one in each set of twenty field samples.

b. Indoor House Dust: field sampling personnel will collect residential dust samples form primary play areas (areas most likely to impact on a child's hands or result in ingestion during indoor activity). A minimum of three areas should be sampled: ~~at~~ the main entrances to the household, and two additional areas most likely to be use by children in the household for play areas. Additional areas for sampling may include secondary entrances to the home (back or side doors), dust on window sills, furniture, and carpet in additional play areas or areas of frequent activity by the children. Bedroom, Kitchen, and living room floor samples will be collected first, followed by floor samples from the entry way. Finally, samples from window wells will be collected.

A representative number of such location(s), comprising not less than ten aliquots, will be proportionally sampled based on their relative areas and apparent degree of use; these are then composited to produce the one sample forwarded to the lab representing the entire play area. Exact locations to be sampled at a given residence will be chosen per the professional judgement of the sampling team leader, and will be fully documented on the field sheets. A corer shall be used to sample the top one inch of soil. Debris and leafy vegetation will be removed from the top of the core, but not soil or decomposed matter; this part of the soil sample is likely to be the highest in metal contamination. Samples will not be taken from locations within one foot of the house foundation per story of the residence unless there is clear indication such areas are in use as play areas, as chipped or peeling exterior paint may produce a typically high readings in such locations.

4. Field Sample Documentation:

   a. **Field Sheets:** Field sheets per SOP 2130.3A shall be used to document locations and times of sampling, as well as all other appropriate details. In particular, sketches should be made of the locations sampled, especially dust and soil samples taken in the play areas, as noted above. E&E shall retain field sheets until instructed otherwise by EPA.

   b. **Sample Chain of Custody:** Sample chain-of-custody forms will be prepared per SOP 2130.2A.

D. **Sample Delivery**

All samples to be analyzed under this play will be delivered to the CLP Laboratory in accordance with applicable SOP, including SOP SG04.0A and 2130.3A. Each set of samples will be delivered along with appropriate field documentation, Chain-of-Custody forms, and "Analytical Services Request Form(s)".

V. **Sample Receipt and Custody**

A. Immediately upon receipt of Study samples the CLP personnel will unpack and inspect the shipment, sign the Chain of Custody form, initiate appropriate internal tracking records, and store the samples in a secure area. If inspection of the shipment causes wither the integrity or condition of the samples to be questioned (e.g. samples not cooled, broken containers, etc.), such observations will be noted on the for transmittal to ATSDR. A draft report summarizing the environmental data collected and an evaluation of the quality of such data shall be supplied to EPA within 150 days of the completion field sampling operations, for transmittal to the individual(s) noted in Section II above. The report will include statements that samples do or do not meet applicable criteria as spelled out in this document and applicable SOPs. Following receipt of U.S. EPA and ATSDR comments on the draft report, a final report shall be submitted to Brad Bradley within 30 days.

IX. Quality Control (QC) Checks

A. The laboratory QC procedures which are incorporated into specific methodologies referenced in Section VI and in SOP 1610.1B will be followed, to include:

1. Method Blanks, at least once per sample preparation batch or one per day (which ever is more frequent), for each medium.

2. Laboratory Duplicates, on 5% of the field samples analyzed or one per sample batch (which ever is more frequent) for each medium.

3. Duplicate Matrix Spikes, on 5% of the field samples analyzed or one set per sample batch (which ever is more frequent). This data will be used to estimate both the precision and accuracy of the reported data.

B. Field QC will include 10% duplicates, field blanks (at least one per day) and Performance Evaluation samples or duplicate field spike soils samples, as discussed in SOP 2110.2A.

X. Performance and System Audits

Neither field audits nor laboratory audits beyond the routine QA/QC oversight of the appropriate supervisors is anticipated for this project, unless specifically determined to be necessary.

XI. Preventive Maintenance (PM)

Preventive maintenance will be performed in accordance with manufacturer's specifications and applicable regional policies and SOP's.

METHOD 3050

ACID DIGESTION OF SEDIMENTS, SLUDGES, AND SOILS

1.0 SCOPE AND APPLICATION

1.1 This method is an acid digestion procedure used to prepare sediments, sludges, and soil samples for analysis by flame or furnace atomic absorption spectroscopy (FLAA and GFAA, respectively) or by inductively coupled argon plasma spectroscopy (ICP). Samples prepared by this method may be analyzed by ICP for all the listed metals, or by FLAA or GFAA as indicated below (see also Paragraph 2.1):

FLAA		GFAA
Aluminum	Magnesium	Arsenic
Barium	Manganese	Beryllium
Beryllium	Molybdenum	Cadmium
Cadmium	Nickel	Chromium
Calcium	Potassium	Cobalt
Chromium	Sodium	Iron
Cobalt	Thallium	Molybdenum
Copper	Vanadium	Selenium
Iron	Zinc	Thallium
Lead		Vanadium

2.0 SUMMARY OF METHOD

2.1 A representative 1/4 to 1/2 g (wet weight) sample is digested in nitric acid and hydrogen peroxide. The digestate is then refluxed with either nitric acid or hydrochloric acid. Dilute hydrochloric acid is used as the final reflux acid for (1) the ICP analysis of As and Se, and (2) the flame AA or ICP analysis of Al, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Mo, Pb, Ni, K, Na, Tl, V, and Zn. Dilute nitric acid is employed as the final dilution acid for the furnace AA analysis of As, Be, Cd, Cr, Co, Pb, Mo, Se, Tl, and V. A separate sample shall be dried for a total solids determination.

3.0 INTERFERENCES

3.1 Sludge samples can contain diverse matrix types, each of which may present its own analytical challenge. Spiked samples and any relevant standard reference material should be processed to aid in determining whether Method 3050 is applicable to a given waste.

4.0 APPARATUS AND MATERIALS

4.1 Conical Phillips beakers: 250-mL.
4.2 Watch glasses.
4.3 Drying ovens: That can be maintained at 30°C.
4.4 Thermometer: That covers range of 0 to 200°C.
4.5 Whatman No. 41 filter paper (or equivalent).
4.6 Centrifuge and centrifuge tubes.

5.0 REAGENTS

5.1 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.2 Concentrated nitric acid, reagent grade (HNO_3): Acid should be analyzed to determine level of impurities. If method blank is <MDL, the acid can be used.

5.3 Concentrated hydrochloric acid, reagent grade (HCl): Acid should be analyzed to determine level of impurities. If method blank is <MDL, the acid can be used.

5.4 Hydrogen peroxide (30%) (H_2O_2): Oxidant should be analyzed to determine level of impurities.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in Chapter Nine of this manual.

6.2 All sample containers must be prewashed with detergents, acids, and Type II water. Plastic and glass containers are both suitable. See Chapter Three, Section 3.1.3, for further information.

6.3 Nonaqeuous samples shall be refrigerated upon receipt and analyzed as soon as possible.

7.0 PROCEDURE

7.1 Mix the sample thoroughly to achieve homogeneity. For each digestion procedure, weigh to the nearest 0.01 g and transfer to a conical beaker a 0.25- 0.50 g portion of sample.

7.2 Add 2 mL of 1:1 HNO_3, mix the slurry, and cover with a watch glass. Heat the sample to 95°C and reflux for 10 to 15 min without boiling. Allow the sample to cool, add 1 mL of concentrated HNO_3, replace the watch glass, and reflux for 30 min. Repeat this last step to ensure complete oxidation.

NIST SRM #	METHOD	206Pb/204Pb	207Pb/204Pb	208Pb/204Pb	Pb(ppm)
277	HF/HNO3	18.992	15.596	38.590	607.8
	EPA3050	18.876	15.670	38.637	557.7/9188
1633A	HF/HNO3	18.881	15.634	38.675	72.59
	EPA3050	18.638	15.445	38.413	19.20/274.9
1646	HF/HNO3	18.767	15.551	38.350	27.76
	EPA3050	18.363	15.588	38.043	32.33/162.4
2704	HF/HNO3	18.681	15.558	38.215	159.2
	EPA3050	18.811	15.641	38.276	138.0/712.7

EXPLANATION

METHOD: HF/HNO3 Sample attacked by a 4:1 48% HF-8N HNO3 mixture; all samples were entirely digested with the exception of NIST SRM # 277.

EPA3050 Sample attacked by EPA Method 3050 which is basically an acid (HNO3/HCl) + H2O2 procedure; the specific method is attached.

Sample weights ranged from 240 to 260 mg with the exception of NIST SRM 1646 where 120 to 130 mg were used (circa 50% of the certification weight).

Pb ISOTOPIC RATIOS: Ratios are precise to ± 0.10% at the 95% confidence level (2 sigma standard error of the mean) and are accurate to better than 0.10% based upon their normalization to NBS SRM 981.

Pb CONCENTRATIONS: Concentration errors are better than 2%. The two values reported for the EPA 3050 method are calculated from (1) the total weight of sample subjected to attack (i.e. 120 - 260 mg; first value) and (2) the total weight of sample actually digested by the EPA 3050 method of extraction (typically 5 - 20%). Note that the EPA 3050 method utilizes the total weight of sample subjected to attack.

MAJOR CONCLUSION: The HF/HNO3 method yields results within the certified Pb concentration error limits while EPA 3050 does not. In one instance (NIST SRM 1646), EPA 3050 yields approximately 20% more Pb than the certified value. The distinct differences between the Pb isotopic ratios obtained from th same sample using the two methods indicates that very different Pb reservoirs are being extracted by the two methods.

7.7 Calculations:

7.7.1 The concentrations determined are to be reported on the basis of the actual weight of the sample. If a dry weight analysis is desired, then the percent solids of the sample must also be provided.

7.7.2 If percent solids is desired, a separate determination of percent solids must be performed on a homogeneous aliquot of the sample.

8.0 QUALITY CONTROL

8.1 For each group of samples processed, preparation blanks (Type II water and reagents) should be carried throughout the entire sample preparation and analytical process. These blanks will be useful in determining if samples are being contaminated.

8.2 Duplicate samples should be processed on a routine basis. Duplicate samples will be used to determine precision. The sample load will dictate the frequency, but 20% is recommended.

8.3 Spiked samples or standard reference materials must be employed to determine accuracy. A spiked sample should be included with each group of samples processed and whenever a new sample matrix is being analyzed.

8.4 The concentration of all calibration standards should be verified against a quality control check sample obtained from an outside source.

9.0 METHOD PERFORMANCE

9.1 No data provided.

10.0 REFERENCES

10.1 None required.

Using a ribbed watch glass, allow the solution to evaporate to 1 mL without boiling, while maintaining a covering of solution over the bottom of the beaker.

7.3 After Step 7.2 has been completed and the sample has cooled, add 1 mL of Type II water and 1 mL of 30% H_2O_2. Cover the beaker with a watch glass and return the covered beaker to the hot plate for warming and to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat until effervescence subsides and cool the beaker.

7.4 Continue to add 30% H_2O_2 in 1-mL aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged.
NOTE: Do not add more than a total of 3 mL 30% H_2O_2.

7.5 If the sample is being prepared for (a) the ICP analysis of As and Se, or (b) the flame AA or ICP analysis of Al, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Na, Tl, V, and Zn, then add 1 mL of concentrated HCl and 3 mL of Type II water, return the covered beaker to the hot plate, and reflux for an additional 15 min without boiling.
Particulates in the digestate that may clog the nebulizer should be removed by filtration, by centrifugation, or by allowing the sample to settle. Evaporate to dryness, cover, store.

conditioning, the average number of cigarettes smoked per day was 35.4 ($p<0.01$). There was an average of 2.4 smokers, smoking a mean of 33 cigarettes per day, in households with children whose blood lead levels were above 0.48 μmol/L (10 μg/dl), and an average of only 1.6 smokers per household smoking a mean of 18 cigarettes per day with children whose blood lead levels were below 0.48 μmol/L (10 μg/dl). This difference was statistically significant ($p<0.01$).

For the children under six neither the original time variables nor the transformed variables of the amount of time spent at home predicted blood lead. The time spent sleeping, playing outside and playing on the floor were of some predictive value and were used in the regression analyses. WHERE DATA?

Clinical laboratory results

The blood and urine specimens were collected between August 23, 1991 and September 20, 1991. Results of blood lead analyses are given in Tables 4-6. The arithmetic mean blood lead levels for each age group were below 0.48 μmol/L (10 μg/dl), the present level of concern of the CDC (CDC 1991). Blood lead was measured in 490 children, 261 males and 229 females between 6 and 71 months of age. Figure 2 shows the distribution of the blood lead levels by year of age in the children under 6. As shown in Figures 2a, 2b, and 2c, the blood lead levels peaked in the children around age 2 and then gradually declined again in older children to values observed around age 1.

Blood lead levels were also determined in 214 youths (ages 6-15 years), 111 males and 103 females, and in 47 males and 76 females over the age of 15. Thus, 827 blood lead determinations were made in all. The arithmetic mean blood lead levels for the youngest age group (between 6 and 71 months of age) was 0.33 μmol/L (6.9 μg/dl) with a range of 0.03-1.94 μmol/L (0.7-40.2 μg/dl). In this group, 78 children (16%) had elevated blood lead levels of 0.48 μmol/L (10 μg/dl) or above. For the children between the ages of 6 and 15 years, the arithmetic mean blood lead level was 0.21 μmol/L (4.4 μg/dl), the range <0.03-0.90 μmol/L (<0.6-18.8 μg/dl). In this group, 8 individuals had blood lead levels of 0.48 μmol/L (10 μg/dl) or above.

Among a total of 101 non-white children under the age of 6 87% were of African-American descent. Of these children, 16% had elevated blood lead levels. The arithmetic mean blood lead levels of all white children under 6 years of age was 0.32 μmol/L (6.8 μg/dl) and for the children of African-American descent, the arithmetic mean was 0.35 μmol/L (7.4 μg/dl). Thus, the blood lead levels of children of African-American descent were quite similar to those of the white children ($t = -1.1$, NS) and 19% had blood lead levels of 0.48 μmol/L (10 μg/dl) or above. These two groups of children were, therefore, combined in the analysis.

Among the children 6 years and older, 17 boys and 16 girls of African-American descent participated in the study. Their arithmetic mean blood lead levels were 0.20 μmol/L (4.2 μg/dl) and 0.23 μmol/L (4.7 μg/dl), respectively. None of these children had blood lead levels of 0.48 µmol/L (10 µg/dl) or above.

The arithmetic mean blood lead levels of participants greater than 15 years of age was 0.17 µmol/L (3.6 µg/dl) with a range of <0.03-0.86 µmol/L (<0.6-17.9 µg/dl). The blood lead levels above 0.48 µmol/L (10 µg/dl) in 3 male participants had resulted from occupational exposure or hobbies. The total number of 43 white adult males had an arithmetic mean blood lead level of 0.28 µmol/L (5.8 µg/dl) and included the 3 males with elevated blood lead levels. Elevated blood lead levels did not contribute to the arithmetic mean blood lead level of 69 adult white females. Their arithmetic mean blood lead level was 0.12 µmol/L (2.4 µg/dl). Among the adult females, 14 were pregnant at the time the blood specimen was drawn. Their blood lead levels ranged from <0.03 µmol/L-0.16 µmol/L (<0.6-3.4 µg/dl) with an average of 0.08 µmol/L (1.6 µg/dl). Three adult males and 7 adult females of African-American descent also participated in the study with arithmetic mean blood lead levels of 0.18 µmol/L (3.8 µg/dl) and 0.17 µmol/L (3.5 µg/dl).

In the youngest age group, 78/490 (16%) had blood lead levels above 0.48 µmol/L (10 µg/dl); however, 46 of these (9% of the 490) had blood lead levels between 0.48-0.72 µmol/L (10-15 µg/dl) and only 5 (1% of the 490) were above the pre-1991 level of concern of 1.21 µmol/L (25 µg/dl) of the CDC (Table 5). A total of 61 children with blood lead levels above 0.48 µmol/L (10 µg/dl) and some of their siblings donated a second blood specimen about 4 months later in January 1992 following extensive counseling of the parents and children. Table 6 shows that the repeat blood lead levels of most children were below 0.48 μmol/L (10 μg/dl) and had dropped to about half or more of their original value. The highest blood lead level was 0.61 μmol/L (12.7 μg/dl). A subset of 30 children of this group was retested about a year after the first testing. At the second testing, a mean blood lead level of 0.39 μmol/L (8 μg/dl) was found in this group. The mean blood lead level at the third testing was 0.43 μmol/L (9 μg/dl) suggesting that the initial drop of the blood lead levels was persistent and not due to seasonal influences or other differences. The data on CBCs of the children under 6 years of age are given in Tables 7 and 8. No difference in the CBC is seen between the children with blood lead levels above and below 0.48 μmol/L (10 μg/dl).

Among the youths 6 to 15 years of age 8 white males had elevated blood lead levels. Four youths had blood lead levels of 0.48 μmol/L (10 μg/dl) and the other four had blood lead levels of 0.6, 0.6, 0.7, 0.9 μmol/L (12.6, 12.7, 13.8 and 18.8 μg/dl). All but one of the families had at least one smoker in the household. In three instances, work had recently been done on the house. In three of the other households, the father worked at home on auto bodies, was engaged in wire cutting and scrap metal recovery, cleaned and repaired firearms, or was also engaged in soldering and auto radiator repair. Thus, in six instances, repair work on the house or work with metals at the home may have contributed to exposure.

Urine cadmium analyses

Results of the urine analysis for cadmium showed that in many specimens cadmium was below the limit of detection of <0.1 μg/L. Only 3 urine specimens contained around 2 μg/L of cadmium. When additional urine specimens were collected from 3 participants whose initial urine contained cadmium at concentrations of 5 μg/L or above, the results of the reanalysis were below the limit of detection of the method of 0.1 μg/L indicating contamination of the initial sample.

Clinical chemistry tests

Urine specimens were tested for albumin, glucose, occult blood, specific gravity and they were examined microscopically. Seven definitely abnormal urines were noted in one adult female and in six children. The children were all females and their ages ranged from one to five. These urines were cloudy in appearance had white and/or red blood cells and bacteria. These findings appeared to be incidental and might be consistent with bladder infections.

Clinical chemistry tests were also performed on the blood specimens (Tables 7 and 8). The electrolytes potassium, sodium, and chlorides, the liver function tests aspartate aminotransferase (AST), alanine aminotransferase (ALT), γ-glutamyltranspeptidase (GGT), and total protein, albumin, blood urea nitrogen, and creatinine were measured. The electrolytes of all participants were within the normal range. One child with a blood lead level of 0.42 µmol/L (8.9 µg/dl) had a definitely elevated blood urea nitrogen of 50 mg/dl, while 2 additional children had levels just outside the reference range of 6-26 mg/dl given by the clinical laboratory. The child with the elevated blood urea nitrogen also had elevated liver function tests with an AST of 171 IU/L, a GGT of 103 IU/L and an ALT of 68 IU/L. Two other children under 6 had an elevated AST of 437 and 83 IU/L. One child had an elevated GGT of 83 IU/L and 1 other child had an elevated ALT of 472 IU/L. One youth had a slightly elevated ALT of 63 IU/L. Among the adults four females had one or more slightly elevated liver function tests. The highest GGT was 75 IU/L and the highest ALT was 61 IU/L. The AST was not elevated in any of the adult female participants. Abnormal liver function tests were also present in six adult male participants. The highest GGT as 195 IU/L and the highest ALT 83 IU/L. The AST was not elevated in any of the adult male participants. Immunoglobulins were also measured in the participants. Immunoglobulin A and G were within the normal range in the study population (Wallach 1992). Immunoglobulin M was elevated in 36 or 4.4% of the participants. Three of these participants had abnormal liver function tests as well. Most likely the elevated immunoglobulin M in participants with normal liver function tests was the result of a chronic infection. Since no clinical information was collected in this study no definite interpretation of these results can be made.

Environmental data

A total of 34% of all participants did not know the age of the house in which they were living. Among the 412 children under 6 with blood lead levels of less than 0.48 μmol/L (10 μg/dl) data on the age of the houses was available for 278. Of those children, 196 or 70% lived in houses that were built before 1950. Of the 78 children with blood lead levels of 0.48 μmol/L (10 μg/dl) or above data on the age of the houses was available for 43. Of those children, 35 or 81% lived in houses built before 1950. Of the children with elevated blood lead levels who lived in houses built after 1950, one child lived in a mobile home and the father was involved in lead related activities. The other houses were built between 1950 and 1970 and remodeling activity or refinishing of furniture had taken place between 1990 and 1991.

Lead levels measured in paint and in soil of the houses are given in Tables 9a and 9b. Houses in which children with elevated blood lead levels lived were not clustered. However, these children were more likely to live closer to the smelter (Figure 1). Of the children under 6 with blood lead levels below 10 μg/dl (0.48 μmol/L), 16% percent lived in sampling area 1, 43% in sampling area 2, 24% in sampling area 3 and 16% in sampling area 4. Among the children whose blood lead levels were above 10 μg/dl, 27% lived in sampling area 1, 53% lived in sampling area 2, 12% lived in sampling area 3 and 8% lived in sampling area 4. Many of the children lived in houses with high paint lead

How do [illegible] compare to population of areas?

concentrations in one or more of the areas measured (Table 9a). Either recent renovation or poorly maintained houses seemed to contribute to the exposure of the children. When the houses were in good condition, increased lead exposure was not as much of a problem.

Overall, about 50% of the families, had done some repair work or renovations on their houses in 1990 or 1991. For families with children under 6 whose blood lead levels were below 0.48 μmol/L (10 μg/dl), 48% had done some work on their house in the last year and 32% did not. In contrast, 63% of the families whose children had blood lead levels above 0.48 μmol/L (10 μg/dl) did some refurbishing in the last year while 38% did not. The difference was statistically significant ($p<0.02$).

In many yards, the lead concentrations in soil were above background levels which locally ranges from below the limit of detection of 1 ppm (mg/kg) to 200 ppm (mg/kg). The mean soil lead level for the 376 analyzed soil samples was 450 ppm (mg/kg) with a range of 37 ppm (mg/kg) to 3010 ppm (mg/kg) (Table 9b). A total of 39 split samples were also analyzed. The concentration of lead in these soil samples ranged from 106 to 1610 ppm (mg/kg). The average difference between the primary and the duplicate sample was 89 ppm (mg/kg).

It is evident from Tables 9a and 9b that there are some very high environmental lead values. For example, the minimum dust lead values is 5.2 mg/kg (ppm), the maximum value is 71,000 mg/kg (ppm), and the standard deviation is nearly four times as great as the mean. Most of the other data were also not normally distributed. Log-transformed data was, therefore, used for most of the statistical analyses.

A total of 376 composite soil samples were also analyzed for cadmium. The arithmetic mean cadmium concentration in soil was 3.1 ppm (mg/kg) with a standard deviation of 1.37. Cadmium was not detected in 8 soil samples at a limit of detection of 3 ppm (3 mg/kg) and all but 7 soil samples were below 6 ppm (mg/kg). The concentrations of cadmium in soil generally ranges from 0.3-11 ppm (mg/kg) (Page and Bingham, 1973; Lund et al., 1981). Thus, cadmium concentrations are within the background range of concentrations found by others.

Lead in drinking water was below the limit of detection of the analytical method of 2 μg/L (ppb) in 62% of the samples of 374 households. A total of 86% of the samples had levels of 5 μg/L (ppb) or less and 97% were below 15 μg/L (ppb), the present USEPA action level. In 13 instances, levels of lead in drinking water were higher with a range of 15.4-95.5 μg/L (ppb). The study participants using this water did not have elevated blood lead levels. The correlation between the log water measure and log blood lead was very low (r = 0.07, N.S.).

The concentrations of cadmium in 374 drinking water samples were below the limit of detection of 0.1 μg/L (ppb) in 322 samples and the maximum concentration detected was 9.9 μg/L (ppb). Only 11 samples were above 2 μg/L (ppb). In a survey of 969 community water supply systems in the United States the average cadmium concentration was 1.3 μg/L (ppb) (Craun and McCabe, 1975) and did not differ from our findings. Furthermore, all of the measurable concentrations were in compliance with the federal drinking water standard of 10 μg/L (ppb) for cadmium.

Levels of lead in dust are also listed in Table 9b. They varied widely, both on a weight basis in ppm (mg/kg)(the concentration of lead in dust) and on the amount of lead present on a given surface area, the loading of dust with lead in $\mu g/m^2$. Among all environmental samples, "dust load" (the amount of lead in dust based on surface area) was the best predictor for blood lead levels of small children. Blood lead levels of children under six were also highly correlated with the "dust load," the concentration of lead in $dust/m^2$ of area vacuumed. The log "dust load" was the highest Pearson correlation of any variable with blood lead levels ($r = 0.42$, $p<0.0001$).

Bivariate analyses

Although bivariate analyses ignore the effects of possible confounding or effect modification from the influence of other variables, they provide a simple first screening of the available data and may even lead to the identification of potential confounders or effect modifiers.

Soil lead, comparing levels of ≥ 500 ppm (mg/kg) to lower levels

A total of 143 children under 6 lived in houses with a composite soil sample of greater or equal to (≥) 500 ppm (mg/kg) lead and 347 children under 6 lived in houses with soil lead levels of less than (<) 500 ppm (mg/kg). These comparisons identified differences in blood lead levels, dust lead levels, indoor and outdoor paint lead levels, the number of cigarettes smoked per day in the house, and the age of the houses. However, the differences were very small for the blood lead levels even though they were statistically significant. The geometric mean blood lead level of children living in houses with soil lead levels of 500 ppm (mg/kg) or above was 0.32 µmol/L (6.6 µg/dl) compared to 0.25 µmol/L (5.2 µg/dl) for children living in houses with soil lead levels below (>) 500 ppm (mg/kg) ($p<0.01$). The differences were larger for other measured parameters. The geometric mean "dust load" in houses with soil lead levels of ≥500 ppm (mg/kg) was 0.4 compared to 0.1 in houses with soil lead levels below (<) 500 ppm (mg/kg) ($p<0.01$). The mean lead concentration in dust on a weight basis rather than surface area was 780 ppm (mg/kg) for houses with soil levels ≥500 ppm (mg/kg) compared to 309 ppm (mg/kg) for houses with soil lead levels below (<) 500 ppm (mg/kg) ($p<0.01$). The geometric mean indoor paint lead level in houses with soil lead levels ≥500 ppm (mg/kg) was 1.4 mg/cm^2 compared to 0.5 mg/cm^2 for houses with soil lead levels below (<) 500 ppm (mg/kg) ($p<0.01$). The geometric mean outdoor paint lead level in houses with soil lead levels of ≥500 ppm (mg/kg) was 8.6 mg/cm^2 compared to 3.0 mg/cm^2 in houses with low soil lead ($p<0.01$). In houses with soil lead levels of ≥500 ppm (mg/kg), 25.5 cigarettes per day were smoked compared to 17.9 cigarettes per day in houses with soil lead levels of less than

(<) 500 ppm (mg/kg) (p<0.01). Houses with soil lead levels of ≥500 ppm (mg/kg) were on the average built between 1920 - 1929, while houses with soil lead levels below (<) 500 ppm (mg/kg) were usually built between 1940 - 1949.

Blood lead

Blood lead is correlated with numerous variables in this data set. All of the following blood lead correlations are statistically significant at p<0.01: Lead in indoor paint, r = 0.16; composite soil lead, r = 0.25; dust lead level, r = 0.25; "dust load," r = 0.42; distance from the defunct lead smelter, r = -0.26; parents' education, r = -0.29; parents' income, r = -0.26; number of smokers in the household, r = 0.16; number of cigarettes per day smoked, r = 0.23; number of hours play outdoors, r = 0.23; and number of baths per week, r = 0.21.

In addition, the following categorical variables are associated (p<0.01) with blood lead if children with high (≥0.48 µmol/L (10 µg/dl)) and low (<0.48 µmol/L(<10 µg/dl)) blood lead levels are compared: air conditioning present/absent; renting versus owning their home; condition of the house; and refinishing of home or furniture (p<0.02).

With so many correlates of blood lead, it is clearly not possible to draw causal inferences without first considering how all of these blood lead predictor variables may influence one another, and confound their relationships with blood lead.

I'd PREFER SUMMARY TABLES INSTEAD OF LISTING RESULTS TEXT.

Soil lead

The most important confounder of the relationship between soil lead and blood lead is the high degree of correlation between composite soil lead and lead in indoor paint, $r = 0.34$. Other correlates of composite soil lead are house "dust load," $r = 0.43$; distance from the smelter, $r = -0.48$; education, $r = -0.11$; income, $r = -0.11$ ($p<0.02$); cigarettes per day, $r = 0.17$; and year the house was built, $r = -0.45$. All correlations are statistically significant ($p<0.01$ unless otherwise noted).

Distance

In this population, distance from the defunct lead smelter is a correlate of blood lead ($r = -0.26$; $p<0.01$). It is tempting to think of distance as a proxy for soil lead exposure because distance is correlated with composite soil lead ($r = -0.48$; $p<0.01$). However, the relationship of distance, composite soil lead, and blood lead is confounded by other variables. Distance is negatively correlated with the number of smokers ($r = -0.24$; $p<0.01$) and the number of cigarettes per day smoked in the house ($r = -0.30$; $p<0.01$). The year the subject's house was built correlates with distance ($r = 0.16$; $p<0.01$). The older houses are closer to the smelter. The parents' educational level ($r = 0.16$; $p<0.01$) and income ($r = 0.18$; $p<0.01$) correlate with distance. The condition of the houses improves with distance from the smelter (Chi-square = 440.0, df = 6; $p<0.01$) and the use of air conditioning increases (Chi-square = 10.8, df = 1; $p<0.01$). As distance increases, dust lead decreases ($r = -0.21$;

p<0.01.); and home ownership increases with distance (Chi-square = 14.3, df = 3; p<0.01). All of these correlates of distance are also associated with one another, and are among the better predictors of blood lead in this study.

Building condition

Building condition is significantly associated with the following variables (p<0.01, except as noted): Cigarettes smoked per day; indoor paint lead; outdoor paint lead; soil lead; water lead (p<0.08); dust lead; parents' education; parents' income; hours of outdoor play; and number of baths per week (p<0.03). Each variable increases steadily over the three levels of building condition, with the exception of water lead.

Building condition is one of the better predictors of blood lead in this population. The mean blood lead level of children living in houses in good condition was 0.29 µmol/L (6 µg/dl). Children living in houses in fair condition had mean blood lead levels of 0.4 µmol/L (8.2 µg/dl) and children living in houses in poor condition had mean blood lead levels of 0.57 µmol/L (11.8 µg/dl). The condition of the house influences the house's "dust load" (a measure that combines dust level and lead concentration). The "dust load" is seven times higher in houses in poor condition than in houses in good condition and about three time higher in houses in fair condition. Building condition is also relatively highly associated with every other predictor of blood lead in this study, and is a confounder in the relationship of composite soil lead and blood lead. Houses in good condition had a mean soil lead concentration of 237 ppm (mg/kg). The mean soil lead concentration for houses in fair condition was 361 ppm (mg/kg) and for houses in poor condition it was 459 ppm (mg/kg). Building condition differs from other potential confounders of the composite soil lead/blood lead association in that the condition of the house is not likely to be a pathway for soil lead exposure. It is one of the few confounders of the soil lead, blood lead relationship that can be controlled for statistically.

Cigarettes per day

In this data set smoking is associated with blood lead. The number of smokers ($r = 0.16$; $p<0.01$), and the number of cigarettes smoked per day ($r = 0.23$; $p<0.01$) both predict blood lead to a degree. However, the number of cigarettes smoked per day is also correlated with "dust load" ($r = 0.15$; $p<0.01$); but not with dust level (i.e. the weight of the dust sample divided by the area vacuumed, $r = 0.005$; $p = 0.92$). The number of cigarettes smoked per day is also correlated with composite soil lead ($r = 0.17$; $p<0.01$), distance from the smelter, parents' education ($r = -0.34$ $p<0.01$), income ($r = -0.20$; $p<0.01$) and outdoor paint lead ($r = 0.11$; $p<0.02$). Furthermore, smokers in houses without air conditioning smoked 35.4 cigarettes per day, while 17.5 cigarettes per smoker were smoked in houses with air conditioning ($t = - 3.8$; $p<0.01$). More cigarettes were smoked in houses in poorer condition ($F = 17.2$, $df = 2$, $p<0.01$); and in older houses ($r = 0.16$; $p<0.01$). It is impossible to determine in this study whether cigarette smoke makes any independent contribution to blood lead in passive smokers, or is simply a proxy for other environmental, socioeconomic, and behavioral factors. Other authors have reported such a contribution (Willers et al., 1989), although in a later paper they were unable to confirm their findings (Willers et al. 1992).

<u>Regression analysis</u>

Because of the many variables in this study expressed as continuous measures, regression analysis provides the best method of analysis. Advantages of regression analysis are the simultaneous analyses of many variables, and the ability to observe the influence of each variable on the other variables. When interrelationships among the variables are complex as in the present study regression analysis may be the only way to express the many relationships (Cohen and Cohen, 1975).

<u>Step-wise regression</u>

Once the list of potential predictor variables was narrowed, the maximum R^2 improvement method was used to select and prioritize the most important predictors. The first variable was dust lead ($R^2 = 0.17$), accounting for about 17% of the total blood lead variance. Second was distance, raising R^2 to 0.21. Third was parents' education, raising R^2 to 0.24; then distance, education, refinishing activities, hours of outside play, and subject's age all traded places in and out of the model for several more steps bringing the R^2 up to 0.32. Ethnicity and lead in drinking water raised R^2 to 0.35.

It is noteworthy that neither ethnicity nor lead in drinking water are significantly associated with blood lead levels in bivariate tests. The fact that they enter the regression ahead of more obvious measures indicates that these two variables may be serving as proxies for other exposures, or that they do not share with other variables any of the little variance in blood lead that they account for individually.

As shown in Table 10, with ten variables in the regression model, R^2 reached 0.37. These variables represented parent education, cigarettes smoked per day, rent/own home, refinishing activities, ethnicity, "dust load," age, water lead, distance, and hours of outdoor play.

While the above approach gives some idea of the role of different variables as predictors of blood lead, the value of the approach is limited. Since this method capitalizes on chance, the p-values associated with partial regression coefficients cannot be interpreted. The hierarchical regression modeling that follows focuses specifically on the contribution of paint and soil lead to blood lead.

Hierarchical regression: the contribution of soil lead to blood lead

The intercorrelation among independent variables in this study, and their correlations with both soil lead and blood lead, suggests that the association of soil lead with blood lead is confounded to some extent by other factors in this study. In order to assess the independent contribution of soil lead to blood lead, it would be desirable to control statistically for potential confounding through hierarchical regression. That is, by first introducing the set of variables that could confound the relationship of soil lead and blood lead, and then introducing the soil lead variable to evaluate the increment in blood lead variance accounted for by soil lead. However, in order to avoid over-adjusting (i.e. inappropriately removing variance in blood lead that could be due to soil lead exposure), a very limited set of potential confounders is used.

As shown in Table 11: Model 1, measures of lead in water, house paint lead, recent household refinishing activities and a rating of the overall building condition (i.e. the general state of repair/disrepair of the residence) account for 11% of the blood lead variance in this study (Adjusted R^2=0.11). These are the only potential confounders of the soil lead/blood lead relationship that were statistically controlled. When composite soil lead measures are added, as shown in Table 11 : Model 2, the adjusted R^2 increases only slightly to Adj R^2 = 0.14. Thus, only 3% of the variance in blood lead observed in this ~~population~~ model is accounted for by soil lead.

How were these select
Are the real confounders

<u>The contribution of soil lead to dust lead</u>

As shown in Table 12: Model 1, the condition of the building, indoor, and outdoor paint lead account for 26% of the variance in dust lead. When composite soil data are added (Table 12: Model 2), R^2 increases to 0.33, an increase of 7% in "dust load" variance. Thus, paint lead and building condition account or about four times as much variance in the current study in dust lead as soil lead.

Effect of including more than one child per family in analyses

Using all children, or only the child with the highest or lowest blood lead level, in the various analyses did not seem to affect the outcome (Table 13). Among families with only one child under six and with more than one child under six the conditions of the houses were quite similar as were the concentrations of lead in soil, lead in paint and lead in dust. The distances of the houses from the defunct smelter were similar as well. The participants rather than the households were, therefore, used in most statistical analyses.

KIND OF LATE TO INFORM THE READER OF THIS!

DISCUSSION

This study was undertaken to determine whether children particularly under the age of six, living in an environment with lead levels in soil above background had elevated blood lead levels. Our results show that in addition to lead in soil other sources of lead also existed in the community, such as high concentrations of lead in indoor and outdoor paint for many houses.

It was not possible to find a separate comparison community of similar socioeconomic configuration and housing stock but with no history of high soil lead concentrations in the vicinity of the study area. Therefore, we included areas adjacent to the area without high concentrations of lead in soil as our control population. Although this control population lived in houses of similar age and with similar concentrations of lead in paint, some other differences also existed.

As distance from the smelter increased, the conditions of the houses improved, in that fewer houses had peeling paint and most houses were owned rather than rented. Furthermore, the educational level of the parents increased, the number of smokers and the amount of smoking decreased, the use of air conditioning increased and other behavioral variables also changed with distance. As we anticipated the concentration of lead in soil also decreased with distance from the defunct smelter. The covariance of risk factors with distance from the smelter makes it more difficult to interpret and analyze our study results. Our study shows that lead exposure risk factors do not occur in isolation. Most of the important lead exposure risk factors occur in and around poorly maintained houses.

The participation rate in our study was not optimal. However, as many people living close to the smelter as living further away were included in the study. If anything, the participation rate closer to the defunct smelter was better. Thus, if high levels of lead in soil were a prominent factor of exposure we would be more likely to detect a soil effect.

In this particular population, the primary exposure of concern was the exposure to lead in young children. It has been documented in many studies that children, because of their hand-to-mouth activities, ingest lead primarily through dust, but they may also ingest paint chips and soil that contain lead. In addition, children will be exposed to lead through food and water. How much environmental lead a child will receive from these various sources depends on many behavioral variables and also on the child's nutrition (ATSDR, 1988).

In this study we made a number of interesting findings. Our most important finding was that most study participants had comparatively low blood lead levels. This is consistent with results obtained by others in recent surveys. Blood lead levels in the population as a whole and in young children are now much lower than they were in the past (Kimbrough, 1993). The decrease in blood lead levels has resulted from the reduction of lead in gasoline and the decreased use of leaded gasoline. Lead in food, particularly in infant food, has also been reduced (Bolger et al., 1991). Lead levels in children in many communities are now around 0.25 μmol/L (5 μg/dl) or less. In the present study, the mean blood lead levels were consistent with these observations. The follow-up studies suggested that seasonal variations in blood lead levels did not occur. Seasonal variations in blood lead levels of children observed in the past may have been related to the variation in the amount of leaded gasoline use in different parts of the year.

It is remarkable that in spite of elevated lead levels in soil and in indoor and outdoor paint, many children had very low blood lead levels. Even the group with elevated blood lead levels had mean blood lead levels that 20 years ago were representative of small children of the general population and were mostly below the CDC level of concern for elevated blood lead levels of 1.21 μmol/L (25 μg/dl) in effect until recently. In the NHANES II survey conducted between 1976-1980 the arithmetic mean blood lead levels for young children were around 0.7-0.97 μmol/L (15-20 μg/dl) (ATSDR 1988). Most of the elevated blood lead levels found in the present study are lower than these levels. Our findings suggest that once the major sources of high levels of lead in air and lead in food have been removed, high lead levels in soil and in paint may make less of a contribution to overall lead exposure than previously assumed. However, this is influenced by individual factors of behavior such as improper renovation of old houses, pica or poorly maintained houses.

As a predictor for blood lead level, education of the head of household is more important than income. Both smoking and remodeling or other repair work on the house were positively correlated with blood lead levels as were lead levels in paint and soil and the age of the house. The educational level and income were inversely correlated with proximity to the defunct smelter.

Blood lead measures in children were used as the dependent variable in a series of regression analyses designed to interpret the contributions made by selected independent variables. The independent variables were grouped differently depending upon the question under investigation. To the extent that these variables predict blood lead and are also correlated with soil lead, they may be confounders of the relationship of blood lead and soil lead.

Some measures are clearly influenced by both soil lead and paint lead. House dust lead is a mixture of soil lead and house paint lead. The number of hours spent at home and the number of hours spent outside, age and sex of the child, and most behavioral variables may serve as predictors of exposure for paint and soil lead. Using these variables to make statistical adjustments is not likely to resolve problems of confounding, and may introduce additional problems of over-adjustment.

A number of variables predicted blood lead levels in young children. These included condition of the house, lead in paint, lead in dust, lead in soil, [illegible] smoking of [illegible] the parents, proximity to the defunct smelter, education and income of the parents, and behavioral factors of the children such as hand-to-mouth activities. Comparing these factors showed that they were all correlated with each other. Only about 40% of the exposure could be accounted for in our data analyses. Of these 40%, lead from soil appears to make a very minor contribution, as an upper-bound at most 3% while the condition of the house and the amount of lead in paint may be responsible for as much as 11%.

Most of the important variables in this study such as education and income of the parents, lead in paint, soil lead, dust lead, behavior variables, smoking and air conditioning are all highly correlated. Thus, correlations, t-tests and Chi-square tests if taken out of context may be misleading. Furthermore, confounding can not be adequately controlled for in the present data set. Many important behavioral variables may affect the degree of exposure to house dust that serves as the primary pathway of exposure for soil lead and house paint lead in small children. Very small but statistically significant differences of a few percent of the variance contributing to blood lead levels have no clinical significance. We attempted to determine, by step-wise regression of 22 variables, what the overall contribution of these variables to lead exposure was. However, as some variables were added to the analyses other variables dropped out and variables that had previously dropped out were in the regression again. This suggested that some of the variables were also proxies for other variables and that they did not constitute meaningful contributions to the exposure of small children.

Since most of the youth and adults had very low blood lead levels, we concentrated our evaluation on the children under six years of age. It is this age group that is the most vulnerable to lead toxicity if high levels of lead are present in their home environment. The few participants with elevated blood lead levels in the older age group acquired their lead through hobbies, occupations pursued by themselves or their fathers, or repair of the house. No detailed statistical analyses were conducted on this group since the number of affected individuals was small and their elevated blood lead levels had individual logical explanations.

An important and often ignored measure of prevention is education about effective ways of reducing exposure and raising awareness and understanding among parents. In this exposure survey, blood lead levels were repeated twice (January 1992 and July 1992) in a subset (61 and 30) of the children with blood lead levels above 0.48 μmol/L (10 μg/dl). Following extensive counseling of the parents about pathways of exposure to lead for children, the follow-up blood lead determinations showed a marked decline in blood lead levels. This improvement persisted during the year's follow-up period in those children that we were able to test repeatedly. It seems that education and involvement of the parents is a very important part of preventing unnecessary lead exposure in children.

Blood lead levels fluctuate somewhat if repeated samples are taken. This variation may occur because of variations in the analytical method (Parsons 1992). Capillary blood specimens are usually higher than venous blood specimens. Venous blood samples provide more accurate results and are preferred although parents may be reluctant to submit their children to a venipuncture. In the past seasonal variations in blood lead levels also occurred. Since lead in air has been reduced, such fluctuations are less of a problem now. However, the improvement of blood lead levels in this group of children persisted for a year and seasonal variations can not be attributed to the reason for the marked improvement in blood lead levels. These findings also illustrate the impact of behavioral factors on blood lead levels and the difficulty in quantifying this impact.

Not all of the parents invited into the study accepted the invitation. A primary reason for refusal was the unwillingness of parents to have their children's blood specimen drawn because of the emotional trauma associated with this event. Parents need to be educated more to the importance of such testing and of preventing excessive exposure to lead. Based on our findings age two would be the optimal age for testing since blood lead levels seem to peak at that age.

STUDY LIMITATIONS SECTION NEEDED. COULD REGROUP SOME OF DISCUSSION SO IT IS MOR ORGANIZED AROUND SPECIFIC TOPICS.

CONCLUSIONS

1. - Blood lead levels of children under the age of 6 and in the older population were for the most part below the new level of concern of 0.48 µmol/L (10 µg/dl) of the CDC.

2. - In our study population, the highest percentage of children with elevated blood lead levels were between 1.5 and 2.5 years of age suggesting that this may be an optimal age for screening. ??

3. - Some children with higher blood lead levels lived in houses close to the defunct smelter but such children also lived in houses further away from the site and outside the USEPA area targeted in 1991 for soil cleanup. WHAT WAS % BY TARGET ARE

4. - The soil lead levels close to the defunct smelter were higher. than ____ GIVE SOME LEVELS BY TARGET AREAS

5. - For small children, house dust serves as a major transfer vehicle of exposure. GIVE MORE DETAIL TO SUPPORT STATEMENT

6. - THIS STUDY SUGGESTS THAT ~~The source of lead in~~ house dust ~~is the~~ lead in paint and soil. IS A MAJOR CORRELATE WITH BLOOD LEADS IN CHILDREN. Paint is the most important contributor to lead in house dust. The amount of lead taken up by children is variable and depends on the CHILD'S BEHAVIOR AND amount of lead in dust, paint and soil.

Qualify

7. - Lead uptake is influenced by many personal variables (e.g. behavior) and variables present in a particular house. These individual factors are difficult to assess. Our

(e.g.

inability to account for 60% of lead uptake underscores that point.

8. ▪ Education of the parents about the lead hazards in their ~~individual homes~~ and suggestions for remedial action and ~~behavior has a~~ may have favorable impact on the children's blood lead levels. MORE STUDY OF THESE PREVENTATIVE ACTIONS IN OTHER INVESTIGATIONS SHOULD BE CONSIDERED

ADD TO #4 ~~9~~ ▪ High levels of lead in soil ~~had little effect on~~ did not strongly correlate with blood lead levels, accounting for 3% of the variance in blood lead.

10. ▪ Our findings suggest that removal of soil as a remedy will generally not have a beneficial effect on children's blood lead levels. CAN'T STATE THIS WAY overstated

11. ▪ Many of the houses inhabited by our study population had high lead paint levels. The lead from the paint particularly in houses that were poorly maintained or had recently undergone repair may have contributed to increased exposure.

THE ANNEX ▪ High concentrations of lead in paint in well-maintained houses did not contribute noticeably to lead exposure. Many of the children with low blood lead levels lived in houses in good condition even with very high lead paint levels.

STUDY LIMITED DUE TO MULTIPLE CORRELATES, LACK OF A CONTROL COMPARISON, ...

RECOMMENDATIONS

Reducing blood lead levels in young children is best accomplished through education of the children and their caretakers and through reducing exposure to paint with high concentrations of lead. Since house dust is the primary transport mechanism through which children are exposed, keeping houses clean and well-maintained ~~is~~ might be the most important factor in reducing lead exposure. Removal of lead contaminated soil will not reduce blood lead levels in children in the Granite City area. Soil removal alone over extended residential areas should generally not be recommended as a solution to reducing lead exposure if lead paint problems are not addressed. Soil removal as the sole remedy should be the exception rather than the rule.

STUDY NOT DESIGN TO TEST OR EVALUATIONS

VERY MUCH OVERSTATED AND RADICALY DOES NOT REPRESENT THE STUDY OR FINDINGS OF REPORT.

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Table 1
Biomedical Tests (blood and urine) [illegible]

Test	Reference range[1]		Expected coefficient of variability (%)[1]
AST (SGOT)[2]	0-6 mo	0-120 IU/L	5.41
	7-12 mo	1-110 IU/L	
	1-5 yr	0-75 IU/L	
	6-10 yr	0-60 IU/L	
	> 10 yr	0-50 IU/L	
ALT (SGPT)[3]		0-50 IU/L	8.33
GGT[4]	Male	0-65 IU/L	6.45
	Female	0-45 IU/L	
Albumin		3.5-5.5 IU/L	2.78
Total protein	Newborn	4.6-7.2 g/dl	3.23
	< 2 yr	5.7-8.2 g/dl	
	≥ 2 yr	60.0-8.5 g/dl	
Creatinine		0.5-1.5 mg/dl	4.76
BUN[5]		7-26 μg/dl	7.14
Electrolytes			
Sodium		135-148 mEq/L	1.43
Potassium		3.5-5.5 mEq/L	2.44
Chloride		94-109 mEq/L	1.98

[1] Provided by the testing laboratories
[2] Aspartate Aminotransferase (S.G.O.T.)
[3] Alanine Aminotransferase (S.G.P.T.)
[4] Gamma-Glutamyltransferase
[5] Blood Urea Nitrogen

Table 2

Study Population
Household Census Data

Census forms with address in study area	5734
Households indicating occupancy	5134
Households with at least one young child	906
Disqualified households (moved, Pontoon Beach)	116
Target households	790
Refused to participate	266
Participating households without child under six	33
Households unaccounted for (no contact, no shows)	169
Total households in study sample	388

Table 3

Household[1]
Participation by Target Sampling Area

Sampling area 1 (closest to Taracorp)	39 census households 20 (51%) households participated
Sampling area 2	201 census households 120 (60%) households participated
Sampling area 3	242 census households 128 (53%) households participated
Sampling area 4 (farthest from Taracorp)	308 census households 120 (39%) households participated

~~census~~

Table 4

Distribution of Blood Lead Levels
by Age of Participant[1]

Age Of Participant	6-71 Months	6-15 Years	>15 Years	Total
Total N	490	214	123	827
Male	261	111	47	419
Female	229	103	76	408
Mean BPb μmol/L	0.33	0.21	0.17	0.28
μg/dl	6.9	4.4	3.6	5.8
Range BPb μmol/L	0.03-1.94	< 0.03-0.90	< 0.03-0.86	< 0.03-1.94
μg/dl	0.7-40.2	< 0.6-18.8	< 0.6-17.9	< 0.6-40.2
Above 0.48 μmol/L (10μg/dl)	78	8	3	89

[1] Nine children included in this table lived at their present residence less than 3 months at the time of the study.

Table 5

Distribution of Blood Lead Levels in
Children between 6 Months and 6 Years of Age
with Blood Lead Levels above 0.48 μmol/L (≥10 μg/dl)

Blood Lead Level	Number	Percent of Total 490 Children
≤ 0.48 μmol/L (≥ 10 μg/dl)	78	16%
≥ 0.48 μmol/L and < 0.72 μmol/L (≥ 10 μg/dl and < 15 μg/dl)	46	9%
≥ 0.72 μmol/L and < 1.21 μmol/L (≥ 15 μg/dl and < 25 μg/dl)	27	5.5%
≥ 1.21 μmol/L (≥ 25 μg/dl)	5	1%

Table 6

Comparison of Original Blood Lead Determination with
4 Month Follow-up Lead Level Determination in 61 Participants[1]

Age	N	1st PBb Range[2]	1st Mean PBb	2nd Pbb Range[2]	2nd Mean PBb	Range[2] of diff	Mean diff
6 months-6 years	51	0.48-1.69 (10-35)	0.72 (15)	0.17-0.61 (4-13)	0.38 (7.8)	0.14-1.16 (3-24)	0.35 (7.2)
6-15 years	7	0.48-0.92 (10-19)	0.63 (13)	0.27-0.44 (6-9)	0.35 (7.3)	0.14-0.48 (3-10)	0.28 (5.9)
> 15 years	3	0.58-0.87 (12-18)	0.68 (14)	0.27-0.47 (6-10)	0.36 (7.4)	0.3-0.4 (6-8)	0.34 (7.0)

[1] Seventeen participants either refused to be followed up or were lost to follow-up
[2] Ranges, means and differences are given in μmol/L and in (μg/dl)

Table 7

Complete Blood Counts (CBC) for 388 Children
6 Months to 6 Years of Age with
Blood Lead Levels below 0.48 μmol/L (<10 μg/dl)[1]

CBC	Mean	Range
White blood cells	$8,332/mm^3$	$3,400-18,400/mm^3$
Hemoglobin	12.2 g/dl	90.0-14.5 g/dl
Hematocrit	36%	25.6-41.7%
Red blood cells	$4.4 \times 10^6/mm^3$	$3.2-5.5 \times 10^6/mm^3$

[1] CBCs were not done on 22 children because insufficient blood was available.

Table 8

Complete Blood Counts (CBC) for 75 Children[1]
6 Months to 6 Years of Age with
Blood Lead Levels above 0.48 μmol/L (≥10μg/dl)

CBC	Mean	Range
White blood cells	9,116/mm^3	5,000-17,600/mm^3
Hemoglobin	12.3 g/dl	80.0-14.7 g/dl
Hematocrit	36%	26.6%-42.8%
Red blood cells	4.5 x 10^6/mm^3	3.7-5.3 x 10^6/mm^3

[1] Three children did not have CBCs done because insufficient blood was available.

Table 9a

Results from XRF Readings of Lead in Paint

Location of Reading	Houses Tested	House with >6 mg/cm^2 Pb (%)
Indoor paint[1]	377	154 (40.8)
Outdoor paint[2]	380	193 (51.0)
Indoor and outdoor paint	371	111 (30.1)

[1] Thirty percent of houses had readings < 1 mg/cm^2 and 29% had >readings between 1 and 6 mg/cm^2.

[2] Twenty two percent of houses had readings < 1 mg/cm^2 and 27% had >readings between 1 and 6 mg/cm^2.

Table 9b

Lead in Environmental Samples:
Soil, Dust and Water

Environmental Sample	N	Mean Pb	Minimum	Maximum	S.D+/-
Soil- dry composite	376	450	37	3010	411
Dust by weight (mg/kg)	371	1283	5.2	71,000	5236
Dust by loading ($\mu g/m^2$)[1]	371	10.02	0.02	58.8	4.7
Drinking H_2O ($\mu g/L$)	388	3.3	< 2	96	7

[1] The "dust load" was calculated by dividing the dust sample weight by the surface area vacuumed and multiplying this ratio by the dust lead concentration.

Table 10

Step-wise Regression Analysis
Dependent Variable: Blood Lead Level in Children between Six Months and Six Years of Age

R^2 = 0.37	F = 21.61; (Prob>F = 0.0001)			
Variable	Parameter Estimate	Standard Error	F Statistic[1]	Prob>F
Intercept	2.88	0.28	106.77	0.0001
Years of Education	-0.04	0.01	5.98	0.0149
Cigarettes per day	0.00	0.00	4.57	0.0331
Rent or own home	-0.12	0.05	4.52	0.0342
Recent remodeling	-0.17	0.05	9.89	0.0018
Race	0.20	0.05	12.45	0.0005
Log of "dust load"	0.13	0.01	59.16	0.0001
Age	-0.08	0.01	20.29	0.0001
Log of lead in water	0.09	0.03	7.81	0.0055
Distance	-0.05	0.01	10.28	0.0015
Hours of outdoor play	0.06	0.01	24.13	0.0001

[1] F is the ratio of the regression mean squares over residual mean squares. $F = R^2 (n - k - 1) / (1 - R^2) k$. The distribution of the F statistic is used to test the significance of R in regression analysis (i.e. to test the null hypothesis that the linear relationship between a set of k independent variables and a dependent variable is zero in the population).

Table 11
Hierarchial Regression Analysis
Dependent Variable: Log Blood Lead in
Children Between 6 Months and 6 Years of Age

MODEL 1

Adj R^2 = 0.11	F = 12.26; (Prob>F = 0.0001)				
Parameter Estimates					
Variable	DP	Parameter Estimate	Standard Error	T for HO: Parameter=0	Prob>|T|
Intercept	1	1.25	0.08	160.02	0.0001
Log of Pb in H^2O	1	0.05	0.03	1.43	0.1546
Log of CXI[1]	1	0.05	0.02	2.99	0.0030
Log of CXO1[1]	1	-0.01	0.01	-0.57	0.5711
Condition of house[2]	1	0.34	0.05	6.79	0.0001
Refurbishing of houses	1	-0.17	0.06	-2.73	0.0067

MODEL 2

Adj R^2 = 0.14	F = 13.09; (Prob>F = 0.0001)				
Parameter Estimates					
Variable	DP	Parameter Estimate	Standard Error	T for HO: Parameter=0	Prob>|T|
Intercept	1	0.56	0.23	2.45	0.0148
Log of Pb in H^2O	1	0.05	0.03	1.55	0.1218
Log of CXI[1]	1	0.04	0.02	2.67	0.0079
Log CXO[1]	1	-0.01	0.01	-10.09	0.2778
Condition of house[2]	1	0.29	0.05	5.61	0.0001
Soil Composite	1	0.17	0.04	4.05	0.0001

[1] Log of CXI, log of CXO are the indoor and outdoor lead paint measurements multiplied by the condition of the house code.

[2] Condition of house is the rating of the overall state of repair/disrepair of the house.

Table 12

Hierarchial Regression Analysis
Dependent Variable: Log "Dust Load"

MODEL 1

Adj R^2 = 0.26	F = 54.18; (Prob>F = 0.0001)				
Parameter Estimates					
Variable	DP	Parameter Estimate	Standard Error	T for HO: Parameter=0	Prob>|T|
Intercept	1	-2.47	0.16	-15.39	0.0001
Log of CXI[1]	1	0.25	0.03	7.32	0.0001
Log of CXO[1]	1	0.05	0.02	1.98	0.0485
Condition of house[2]	1	0.73	0.11	6.98	0.0001

MODEL 2

Adj R^2 = 0.33	F = 55.00; (Prob>F = 0.0001)				
Parameter Estimates					
Variable	DP	Parameter Estimate	Standard Error	T for HO: Parameter=0	Prob>|T|
Intercept	1	-5.52	0.47	-11.84	0.0001
Log of CXI[1]	1	0.20	0.03	6.45	0.0001
Log CXO[1]	1	-0.03	0.02	0.03	0.9773
Condition of house[2]	1	0.65	0.11	5.58	0.0001
Soil Composite	1	0.54	0.08	6.43	0.0001

[1] Log CXI, CXO are the indoor and outdoor lead paint measurements multiplied by the condition of the house code.

[2] Condition of house is the rating of the overall state of repair/disrepair of the house.

Table 13

Geometric Means of Environmental Testing from Families
with more than One Child under Six and Families with only One Child under Six

Parameter	Households with Two or More Children Under 6		Households with One Child Under 6	
	Mean level of Parameter[1]		Mean level of Parameter[1]	
	BPb<10 µg/dl	BPb ≥ µg/dl	BPb <10 µg/dl	BPb ≥ 10 µg/dl
Distance to smelter[2]	5.3	4.5	5.4	4.7
CXRFI[3]	0.7	1.2	0.6	10.0
CXRFO[4]	3.8	6.7	3.4	5.7
Indoor lead/paint[5]	0.8	1.1	0.7	10.0
Composite soil sample[6]	310	503	303	488
"Dust load"[7]	0.2	0.7	0.15	0.6

[1] All environmental measures are statistically significantly different at the $p < 0.05$ level between the high blood lead (≥10 µg/dl) and the low blood lead group for both households with one child and households with more than one child.
[2] Distance to the smelter is an arithmetic mean.
[3] CXRFI is the average indoor XRF reading in mg/cm² multiplied by the condition code of the house.
[4] CXRFO is the average outdoor XRF reading in mg/cm² multiplied by the condition code of the house.

[5] Indoor lead paint is the average indoor XRF lead paint reading in mg/cm.²
[6] EPA soil sample is the lead concentration in ppm (mg/kg) of a composite soil sample taken from different areas of the yard including play areas.
[7] "Dust load" is the amount of dust (in µg) collected from a m² of area in the house.

FIGURES

Legend for Figure 1

Figure 1 Map of the study area showing the distribution of the houses. The closed circles represent houses with children with blood lead levels below 0.48 μmol/L (10 μg/dl). The open squares represent houses with children with blood lead levels of 0.48 μmol/L (10 μg/dl) or above.

ATTACHMENTS

GRANITE CITY LEAD EXPOSURE STUDY

FIGURES 1, 2a, 2b, 2c

VENICE
MADISON
TARACORP
ROCKS
CANAL
N

APPROVED BY
SCRIHS
10-20-91
Date

INFORMED CONSENT FORM

Informed consent consists of the following elements:

- A fair explanation in terms the subject can understand, of the procedures to be followed and their purposes including an identification of those which are experimental and a statement of the expected duration of the subject's participation;

- A description of any reasonably foreseeable discomforts or risks;

- A description of any benefits reasonably to be expected;

- A disclosure of any appropriate alternative procedures that might be advantageous for the subject;

- A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained. If the protocol is a FDA study, a statement should be added to the standard paragraph on confidentiality that the subject understands his or her identity will be revealed to the FDA;

- An explanation of compensation for injuries incurred in research;

- An offer to answer any inquiries concerning procedures;

- An instruction that the subject is free to withdraw his/her consent and to discontinue participation in the project or activity at any time without prejudice to the subject;

- No language through which the subject is made to waive or to appear to waive any of his/her legal rights or to release the institution or its agents from liability or negligence.

The following additional elements may be required depending on the nature of the protocol:

- A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable;

- Anticipated circumstances under which the subject's participation may be terminated by the research investigator without regard to the subject's consent;

- The consequences of a subject's decision to withdraw from the research and procedures for orderly termination of participation by the subject;

- A statement that significant new findings developed during the course of the research which may relate to the subject's willingness to continue participation will be provided to the subject; and;

- The approximate number of subjects involved in the study.

Individuals responsible for this research protocol;

Fred Stallings
Sara Sarasuwa
Agency for Toxic Substances and Disease Registry
Executive Park
Atlanta, Georgia
(404) 639-0564

Thomas Long
Catherine Copley
Illinois Department of Public Health
Division of Environmental Health
525 West Jefferson
Springfield, IL 62761
(217) 782-5830

Title of protocol: Multisite Heavy Metals Exposure Study in Illinois, Kansas, and Missouri

Expected duration of patient involvement in study: It will take approximately 1 and 1/2 hours to review this consent form, complete the questionnaire, collect the urine sample, and collect the biological samples. It will take at least 1 hour to collect soil, water, paint, and dust samples from my home.

I (My child/ward) agree(s) to participate as a subject in this research project, the main purpose of which is: To determine levels of heavy metals in blood and urine in people living in the study area to compare to those levels found in people living outside the study area as well as to currently accepted health guidelines; to determine any relationship between heavy metal levels found in blood and urine and levels in soil, dust, paint, and water; to determine risk factors for exposure to lead and cadmium.

Description of research protocol (to include objectives, purposes, selection of patients, procedures to be followed, treatment plan, etc.): The Illinois Department of Public Health (IDPH) with assistance from the Agency for Toxic Substances and Disease Registry of the U.S. Public Health service, is conducting an exposure study of heavy metal contamination in residential areas surrounding the N L Industries/Taracorp National Priority List (NPL) site in Granite City, Illinois. I am being asked to participate in this study:

1. To determine if there is a statistical relationship between activities and/or situations in and around the home and the amount of heavy metals found in my (child's/ward's) body.

2. To compare the levels of heavy metals found in my (child's/ward's) blood to the levels of blood components.

3. To compare the results of my community's exposure with people living in areas contaminated to both industrial and mining emissions.

As a resident, I am being asked to participate in order to determine the degree of my (child's/ward's) exposure to heavy metals. This study will include some people living within two miles of the NPL site. The individuals doing this study would like to include all children between the ages of 6 months through 71 months. Some older children and adults, chosen randomly, like tossing a coin, will be asked to participate. My (child's/ward's) part in the study may include:

1. Answering questions about habits and activities in and around the home and about the occupations of adults in the home. This interview will require about one hour.

2. Permitting a blood sample not to exceed 30 milliliters (about 2 tablespoons) to be taken with a sterile needle from a vein in the arm.

3. Providing a urine sample by voiding into a cup in the privacy of an enclosed area. Instructions will be given to help my (my child/ward) use the cup to collect urine. Parents will be asked to help small children.

4. Allowing environmental samples to be collected from in and around the home at a later date. This will require IDPH or their representatives to enter my home and conduct a test of exterior and interior paint which will cause minimal damage to paint. In addition, water, dust, and soil samples will be collected to be analyzed for lead and cadmium.

I understand that of the procedures described above, the following are experimental procedures: None.

I understand that the reasonable foreseeable risks or discomforts may be as follows: There is little risk associated with the blood drawing procedure. The needle will be left in my (child's/ward's) arm for a few minutes. I (My child/ward) can expect to experience some pain at the moment the needle goes into the arm. In about 10 percent of cases, a small amount of bleeding under the skin will produce a bruise (hematoma). There is a small risk of fainting.

I understand that the benefits which may reasonably be expected from my (my child's/ward's) participation in this study are: In 6 to 8 months IDPH will send me a letter with my (my child's/ward's) test results and results of the environmental sampling, at no charge. If the results of medical tests indicate a possible problem, I will be notified

Discussion of additional elements of informed consent, if applicable. If none are applicable, please state.

Confidentiality is assured since IDPH will take every reasonable precaution to keep my (my child's/ward's) records confidential. Any information shared with the Agency for Toxic Substances and Disease Registry or Centers for Disease Control will be kept in accordance with the Federal Privacy Act of 1974 and will not include information which identifies me (my child/ward) personally. Any reports of this study will not identify specific individuals and will only give group information.

We understand that we may be asked to participate in future studies to measure heavy metal blood levels and environmental contamination concentration changes over time.

This protocol has been reviewed and approved by the Springfield Committee for Research Involving Human Subjects as preserving safeguards of subjects' privacy, welfare, and civil liberties. The Chairman of the Committee may be reached through the Office of the Dean and Provost, Southern Illinois University School of medicine, 801 North Rutledge Street, Springfield, Illinois 62708, telephone (217) 782-3318.

I may contact the following person to answer any inquiries I may have concerning this research protocol and my rights as a research subject: Catherine Copley; Illinois Department of Public Health; 525 West Jefferson; Springfield, IL 62761; (217) 782-5830 or David Webb; Illinois Department of Public Health; 22 Kettle River Drive; Edwardsville, IL 62025; (618) 656-6680.

I understand that my (child's/ward's) participation in this study is entirely voluntary and that I may decline to enter this study or withdraw from it any time. If I wish to withdraw, I understand that it is important to notify my doctor so that he or she can plan for my continuing medical care.

Any information obtained from this investigation which can be identified with me will remain confidential or will be disclosed only with my permission. Should any publication or public presentation result from this study, my (child's/ward's) identity will not be revealed.

I understand, in the event of any research-related injury resulting from research procedures, that financial compensation is not available, but that immediate medical treatment for injuries is available at usual and customary fees at St. Elizabeth's Medical Center in Granite City, Illinois. I also understand that should I (my child/ward) suffer any physical injury as a result of participation in the research program, I may contact the Chairman, Springfield Committee for Research Involving Human Subjects, Southern Illinois University School of Medicine, 801 North Rutledge Street, Springfield, Illinois, 62708, telephone number (217) 782-3318, who will review the matter with me and identify any other resources that may be available to me.

Printed Name of Participant: ______________________________

Signatures:

____
Subject, Legal Guardian, or Next of Kin Date

____
Participant under 18 Years of Age Date

____
Principal Investigator Date

____
Witness Date

(Date consent form approved by SCRIHS: 6/20/91) soon as possible. Otherwise, IDPH will notify me of the results as soon as all tests are done. If further medical evaluation is indicated, recommendations will be given to seek further medical advice. Test results will be sent to my family physician if I request it in writing. Recommendations to reduce the amount of exposure to lead and/or cadmium will be provided if results reflect excessive lead or cadmium exposure.

I am aware that the following alternative procedures could be advantageous to me: Getting the same tests done by a private company or laboratory. I could choose to do nothing.

Discussion of additional elements or informed consent, if applicable. If none are applicable, please state.

IDPH will take every reasonable precaution to keep my (my child's/ward's) records confidential.

This protocol has been reviewed and approved by the Springfield Committee for Research Involving Human Subjects as preserving safeguards of subjects' privacy, welfare, and civil liberties. The Chairman of the Committee may be reached through the Office of the Dean and Provost, Southern Illinois University School of Medicine, 801 North Rutledge Street, Springfield, Illinois 62708, telephone (217) 782-3318.

I may contact the following person to answer any inquiries I may have concerning this research protocol and my rights as a research subject: Catherine Copley; Illinois Department of Public Health; 525 West Jefferson; Springfield, IL 62761; (217) 782-5830 or David Webb; Illinois Department of Public Health; 22 Kettle River Drive; Edwardsville, IL 62025; (618) 656-6680.

I understand that my (child's/ward's) participation in this study is entirely voluntary and that I may decline to enter this study or withdraw from it any time.

Any information obtained from this investigation which can be identified with me will remain confidential or will be disclosed only with my permission. Should any publication or public presentation result from this study, my (child's/ward's) identity will not be revealed.

I understand, in the event of any research-related injury resulting from research procedures, that financial compensation is not available, but that immediate medical treatment for injuries is available at usual and customary fees at St. Elizabeth's Medical Center in Granite City, IL. I also understand that should I (my child/ward) suffer any physical injury as a result of participation in the research program, I may contact the Chairman, Springfield Committee for Research Involving Human Subjects, Southern Illinois University School of Medicine, 801 North Rutledge Street, Springfield, IL, 62708, telephone number (217) 782-3318, who will review the matter with me and identify any other resources that may be available to me.

Printed Name of Participant: ______________________________

Signatures:

____
Subject, Legal Guardian, or Next of Kin   Date

____
Participant under 18 Years of Age   Date

____
Principal Investigator   Date

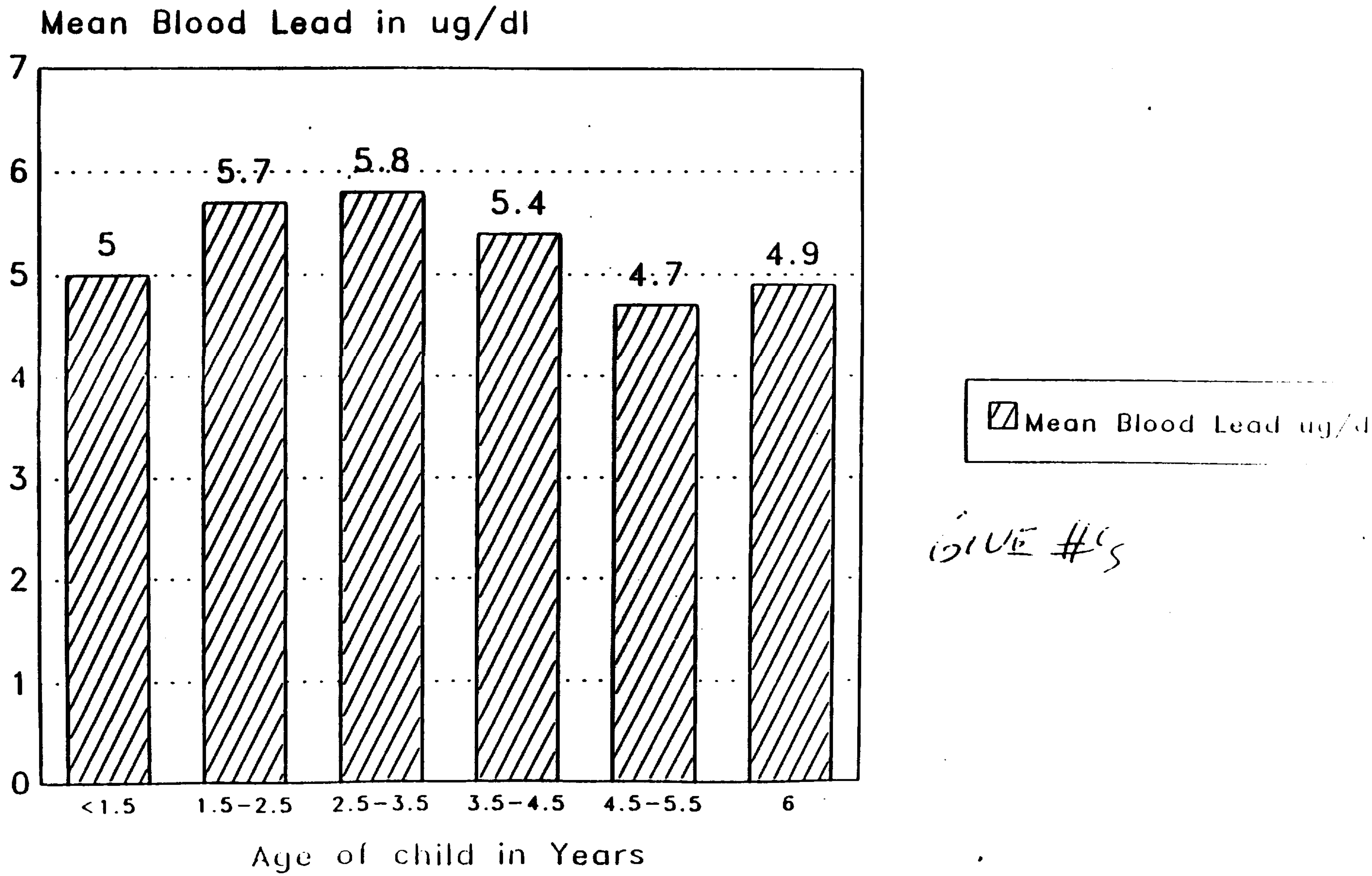
____
Witness   Date

APPROVED BY
SCRIHS
6/20/91
Date

Amended 7/3/91
Approved 7/3/91

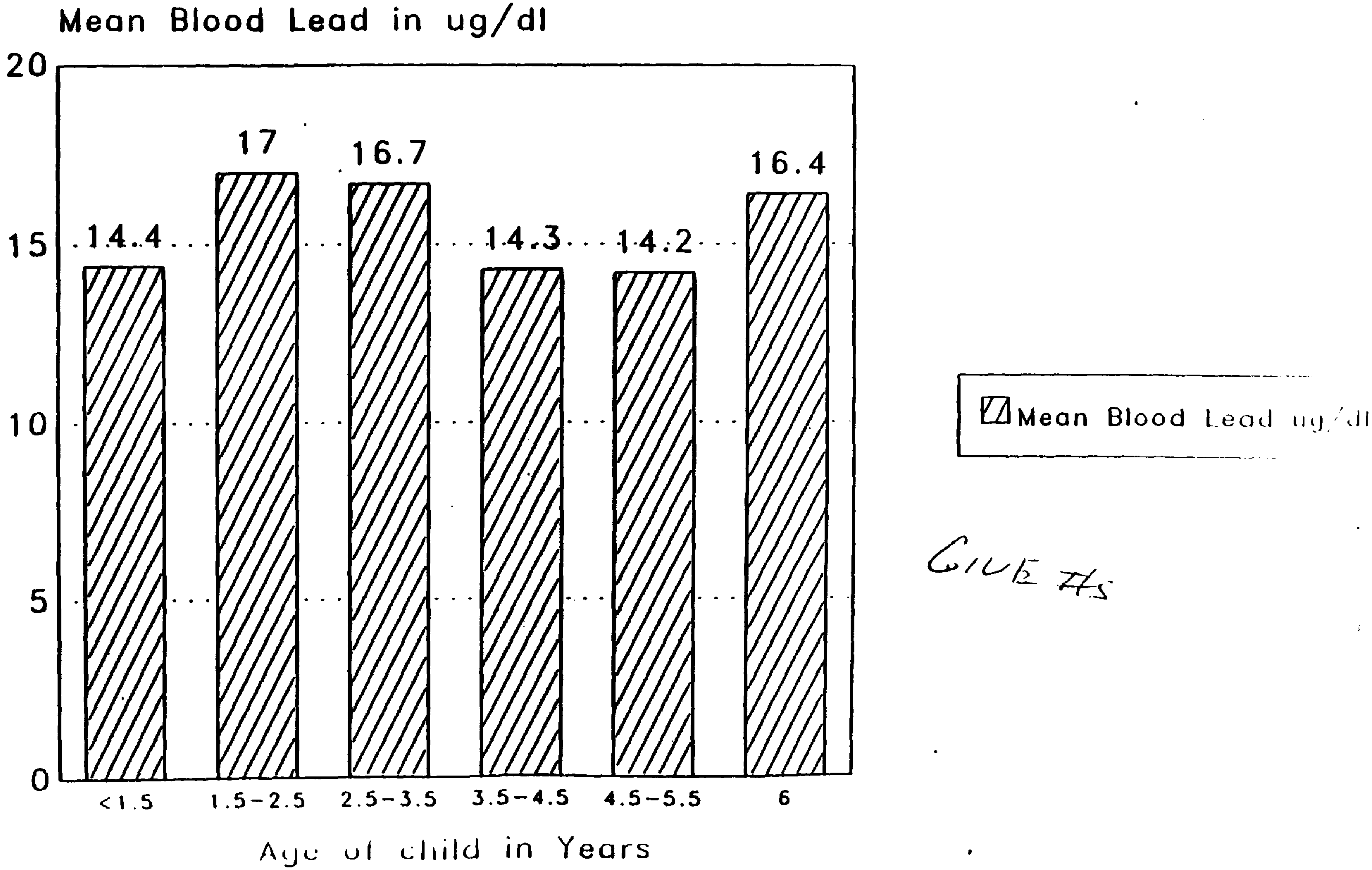
amended 4/92
approved 4/92

Fig 2a
Mean Blood Lead Levels by Age Group
For Children with Blood Lead Levels Less than or Equal to 10 ug/dl N=485



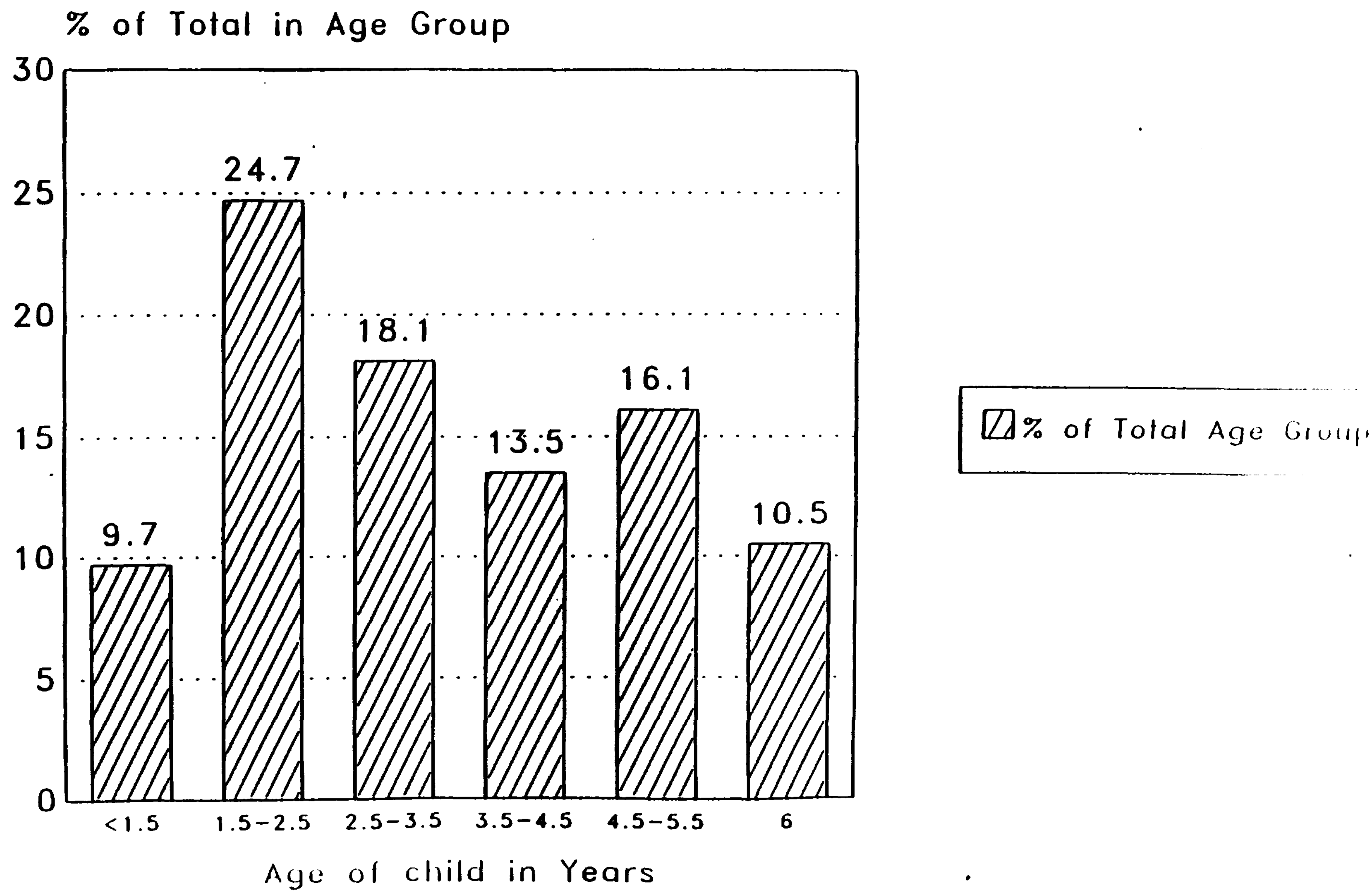
GIVE #5

Fig 2b
Mean Blood Lead Levels by Age Group
For Children with Blood Lead Levels Greater than or Equal to 10 ug/dl N=78



GIVE #s

Fig 2c
Percent of Children in Each Age Group with Lead Level Greater than or Equal to 10 ug/dl
N=78



GRANITE CITY LEAD EXPOSURE STUDY

ATTACHMENTS 1-5

ATTACHMENT 1

Illinois Department of Public Health
Madison County Lead Study
Census Form
Summer 1991

Census Block # ______
Census Taker ID ______
Census Household # 923

House Address ____________________
City ______________ Zip ________ Phone ______________

Check here if refused to answer all questions ______

List on the numbered lines below the names of each person living in this house or apartment. Begin with the head of the household and include all persons staying here who have no other home.

INCLUDE	DO NOT INCLUDE
Everyone who usually lives here such as family members, housemates and roommates, foster children, roomers, boarders, and live-in workers.	Persons who usually live somewhere else.
	Persons who are institutionalized.
Persons who are temporarily away on a business trip, on vacation, or in a general hospital.	
College students who stay here while attending college.	College students who live somewhere else while attending college.
Persons in the Armed Forces who live here.	
Newborn babies still in the hospital.	Persons in the Armed Forces who live somewhere else.
Children in boarding schools below the college level.	
Persons who stay here most of the week while working even if they have a home somewhere else.	Persons who stay somewhere else most of the week while working.

	Last	First	Initial
Person 1 (head):			
Person 2:			
Person 3:			
Person 4:			
Person 5:			
Person 6:			
Person 7:			
Person 8:			
Person 9:			
Person 10:			
Person 11:			
Person 12:			

Illinois Department of Public Health
Madison County Lead Study

[illegible] Form

Summer 1991

Census Block # ____________

Census Taker ID ____________

Census Household # ____________

CIRCLE THE BEST ANSWER AND WRITE NUMBER IN LOWER RIGHT HAND CORNER OF BOX

#1

Which describes this building best?

1. Mobile home or trailer
2. One family house detached from any other house
3. Duplex
4. Row house
5. Building with 2 apartments or less
6. Building with 3 or 4 apartments
7. Building with 5 to 9 apartments
8. Building with 10 or more apartments
9. Don't know

#2

How many rooms are in this house or apartment, excluding bathrooms or halls?

1. 2 or less
2. 3 to 4 rooms
3. 5 to 6 rooms
4. 7 to 8 rooms
5. 9 to 10 rooms
6. 11 or more rooms
7. Refused response
9. Don't know

#3

What year was this house or apartment built?

1. Before 1879
2. 1880 to 1899
3. 1900 to 1919
4. 1920 to 1939
5. 1940 to 1959
6. 1960 to 1979
7. 1980 to present
8. Refused response
9. Don't know

#4

Is this house or apartment

1. Owned by you or someone in this household with mortgage or loan?
2. Owned by you or someone in this household free and clear (without a mortgage)?
3. Rented for cash rent?
4. Occupied without payment of cash rent?
5. Other ____________________
6. Refused response
9. Don't know

#5

Which of the following best describes the highest level of education completed by the head of this household?

1. Grade school
2. Some high school
3. High school
4. Some college
5. College (BA, BS, RN, LPN, etc.)
6. Some postgraduate work
7. Postgraduate work (Master's, Ph.D. J.D., M.D., etc.)
8. Refused response
9. Don't know

#6

How long have you and your family occupied this apartment or house?

1. Less than 2 months
2. 3 months to 11 months
3. 1 year to 2 years
4. 3 years to 5 years
5. 6 years to 8 years
6. 9 years or more
7. Refused response
9. Don't know

#7

Is anyone in this residence pregnant?

1. Yes
   If yes, please give first name(s)
   ____
   ____
2. No
3. Refused response
9. Don't know

Illinois Department of Public Health
Madison County Lead Study

us Form

Summer 1991

Census Block # ____________

Census Taker ID ____________

Census Household # ____________

CIRCLE THE BEST ANSWER AND WRITE NUMBER IN LOWER RIGHT HAND CORNER OF BOX

Fill one column for each person listed on second page	Person # 1 Name ______	Person # 2 Name ______	Person # 3 Name ______	Person # 4 Name ______
#8 Is person 2 and others related to person 1?				
1. Yes (go to #9A)		1	1	1
2. No (go to #9B)		2	2	2
#9 A. How are they related?				
1. Husband/wife		1	1	1
2. Natural-born/adopted/son/daughter		2	2	2
3. Step or foster child		3	3	3
4. Father/mother		4	4	4
5. Grandchild		5	5	5
6. Other		6	6	6
7. Refused response		7	7	7
9. Don't know		9	9	9
B. If not related:				
1. Roomer, boarder		1	1	1
2. Housemate, roommate		2	2	2
3. Unmarried partner		3	3	3
4. Other non-relative		4	4	4
5. Refused response		5	5	5
9. Don't know		9	9	9
#10 Describe race of persons in your household.				
1. Caucasian	1	1	1	1
2. African-American	2	2	2	2
3. Indian American	3	3	3	3
4. Eskimo or Aleut	4	4	4	4
5. Asian/Pacific Islander	5	5	5	5
6. Other	6	6	6	6
7. Refused response	7	7	7	7
9. Don't know	9	9	9	9
#11 Sex	1. M 2. F	1. M 2. F	1. M 2. F	1. M 2. F
#12 Age in Years	______	______	______	______
#13 Date of Birth (MM/DD/YY)	__/__/__	__/__/__	__/__/__	__/__/__
#14 Marital Status				
1. Now married	1	1	1	1
2. Widowed	2	2	2	2
3. Divorced	3	3	3	3
4. Separated	4	4	4	4
5. Single	5	5	5	5
6. Refused response	6	6	6	6
9. Don't know	9	9	9	9

Illinois Department of Public Health
Madison County Lead Study

Census Block # ____________

Form

Census Taker ID ____________

Summer 1991

Census Household # ____________

CIRCLE THE BEST ANSWER AND WRITE NUMBER IN LOWER RIGHT HAND CORNER OF BOX

Fill one column for each person listed on second page	Person # 5 Name ____	Person # 6 Name ____	Person # 7 Name ____	Person # 8 Name ____
#8 Is person 2 and others related to person 1?				
1. Yes (go to #9A)	1	1	1	1
2. No (go to #9B)	2	2	2	2
#9 A. How are they related?				
1. Husband/wife	1	1	1	1
2. Natural-born/adopted/ son/daughter	2	2	2	2
3. Step or foster child	3	3	3	3
4. Father/mother	4	4	4	4
5. Grandchild	5	5	5	5
6. Other	6	6	6	6
7. Refused response	7	7	7	7
9. Don't know	9	9	9	9
B. If not related:				
1. Roomer, boarder	1	1	1	1
2. Housemate, roommate	2	2	2	2
3. Unmarried partner	3	3	3	3
4. Other non-relative	4	4	4	4
5. Refused response	5	5	5	5
9. Don't know	9	9	9	9
#10 Describe race of persons in your household.				
1. Caucasian	1	1	1	1
2. African-American	2	2	2	2
3. Indian American	3	3	3	3
4. Eskimo or Aleut	4	4	4	4
5. Asian/Pacific Islander	5	5	5	5
6. Other	6	6	6	6
7. Refused response	7	7	7	7
9. Don't know	9	9	9	9
#11 Sex	1. M 2. F	1. M 2. F	1. M 2. F	1. M 2. F
#12 Age in Years	____	____	____	____
#13 Date of Birth (MM/DD/YY)	__/__/__	__/__/__	__/__/__	__/__/__
#14 Marital Status				
1. Now married	1	1	1	1
2. Widowed	2	2	2	2
3. Divorced	3	3	3	3
4. Separated	4	4	4	4
5. Single	5	5	5	5
6. Refused response	6	6	6	6
9. Don't know	9	9	9	9

Illinois Department of Public Health
Madison County Lead Study

B Form

Summer 1991

Census Block # ____________

Census Taker ID ____________

Census Household # ____________

CIRCLE THE BEST ANSWER AND WRITE NUMBER IN LOWER RIGHT HAND CORNER OF BOX

Fill one column for each person listed on second page	Person # 9 Name ______	Person # 10 Name ______	Person # 11 Name ______	Person # 12 Name ______
#8 Is person 2 and others related to person 1?				
1. Yes (go to #9A)	1	1	1	1
2. No (go to #9B)	2	2	2	2
#9 A. How are they related?				
1. Husband/wife	1	1	1	1
2. Natural-born/adopted/son/daughter	2	2	2	2
3. Step or foster child	3	3	3	3
4. Father/mother	4	4	4	4
5. Grandchild	5	5	5	5
6. Other	6	6	6	6
7. Refused response	7	7	7	7
9. Don't know	9	9	9	9
B. If not related:				
1. Roomer, boarder	1	1	1	1
. Housemate, roommate	2	2	2	2
3. Unmarried partner	3	3	3	3
4. Other non-relative	4	4	4	4
5. Refused response	5	5	5	5
9. Don't know	9	9	9	9
#10 Describe race of persons in your household.				
1. Caucasian	1	1	1	1
2. African-American	2	2	2	2
3. Indian American	3	3	3	3
4. Eskimo or Aleut	4	4	4	4
5. Asian/Pacific Islander	5	5	5	5
6. Other	6	6	6	6
7. Refused response	7	7	7	7
9. Don't know	9	9	9	9
#11 Sex	1. M 2. F	1. M 2. F	1. M 2. F	1. M 2.F
#12 Age in Years	______	______	______	______
#13 Date of Birth (MM/DD/YY)	__/__/__	__/__/__	__/__/__	__/__/__
#14 Marital Status				
1. Now married	1	1	1	1
:. Widowed	2	2	2	2
3. Divorced	3	3	3	3
4. Separated	4	4	4	4
5. Single	5	5	5	5
6. Refused response	6	6	6	6
9. Don't know	9	9	9	9

Illinois Department of Public Health
Madison County Lead Study

Census Block # ____________

Census Form

Census Taker ID ____________

Summer 1991

Census Household # ____________

ANIMAL DATA - CIRCLE THE ANSWER THAT BEST APPLIES

1. Do you keep a cat or dog at your dwelling?

    1. Yes (if yes go to next question)
    2. No

2. If yes, what is the species, sex, age, and how long had you had each individual animal?

Animal #	1	2	3	4	5	6
Name						
Species 1. Dog 2. Cat	1 2	1 2	1 2	1 2	1 2	1 2
Sex 1. Male 2. Female 3. Neutered	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Age in months or DK*	____ DK	____ DK	____ DK	____ DK	____ DK	____ DK
Months of Possession or DK*	____ DK	____ DK	____ DK	____ DK	____ DK	____ DK

*DK-don't know

Years	Months	Years	Months	Years	Months
0.5	6	5.5	66	10.5	126
1.0	12	6.0	72	11.0	132
1.5	18	6.5	78	11.5	138
2.0	24	7.0	84	12.0	144
2.5	30	7.5	90	12.5	150
3.0	36	8.0	96	13.0	156
3.5	42	8.5	102	13.5	162
4.0	48	9.0	108	14.0	168
4.5	54	9.5	114	14.5	174
5.0	60	10.0	120	15.0	180

Illinois Department of Public Health

Madison County Lead Study Census Block # __________

Summer 1991

The Illinois Department of Public Health thanks you for your cooperation. The census information given to the Illinois Department of Public Health will be used to help determine which particular areas to study. We need some of this information to choose groups of residents that may be exposed to lead as well as similar groups of residents that are not exposed.

You should have received a copy of the consent form that will be used for this study. We are distributing this now so that you have plenty of time to read it in advance if you are asked to participate.

If you did not receive a copy of the consent form or if you have any further questions regarding this study, please contact:

Tom Long
Illinois Department of Public Health
Division of Environmental Health
525 West Jefferson Street
Springfield, Illinois 62761
(217) 782-5830

David Webb
Illinois Department of Public Health
22 Kettle River Drive
Edwardsville, IL 62025
(618) 656-6680

Cathy Copley, Illinois Department of Public Health
2125 S. First Street
Champaign, IL 61820
(217) 333-6914

*** LEAVE THIS PAGE AT HOUSEHOLD AFTER CENSUS COMPLETED ***

Printed by Authority of the State of Illinois
P.O. 53010 7M 7/91

PROTECTION OF HUMAN SUBJECTS
ASSURANCE/CERTIFICATION/DECLARATION

[X] ORIGINAL [ ] FOLLOWUP [ ] EXEMPTION (previously undesignated)

[X] New [ ] Competing continuation [ ] Noncompeting continuation [ ] Supplemental

APPLICATION IDENTIFICATION NO. (if known)

POLICY: A research activity involving human subjects that is not exempt from HHS regulations may not be funded unless an Institutional Review Board (IRB) has reviewed and approved the activity in accordance with Section 474 of the Public Health Service Act as implemented by Title 45, Part 46 of the Code of Federal Regulations (45 CFR 46—as revised). The applicant institution must submit certification of IRB approval to HHS unless the applicant institution has designated a specific exemption under Section 46.101(b) which applies to the proposed research activity. Institutions with an assurance of compliance on file with HHS which covers the proposed activity should submit certification of IRB review and approval with each application. (In exceptional cases, certification may be accepted up to 60 days after the receipt date for which the application is submitted.) In the case of institutions which do not have an assurance of compliance on file with HHS covering the proposed activity, certification of IRB review and approval must be submitted within 30 days of the receipt of a written request from HHS for certification.

1. TITLE OF APPLICATION OR ACTIVITY

Multistate heavy metals exposure study in Illinois, Kansas, and Missouri (Summer 1991)

2. PRINCIPAL INVESTIGATOR, PROGRAM DIRECTOR, OR FELLOW

Thomas F. Long

3. FOOD AND DRUG ADMINISTRATION REQUIRED INFORMATION (see reverse side)

4. HHS ASSURANCE STATUS

[X] This institution has an approved assurance of compliance on file with HHS which covers this activity.

M1311 Assurance identification number 01 IRB identification number

[ ] No assurance of compliance which applies to this activity has been established with HHS, but the applicant institution will provide written assurance of compliance and certification of IRB review and approval in accordance with 45 CFR 46 upon request.

5. CERTIFICATION OF IRB REVIEW OR DECLARATION OF EXEMPTION

[X] This activity has been reviewed and approved by an IRB in accordance with the requirements of 45 CFR 46, including its relevant Subparts. This certification fulfills, when applicable, requirements for certifying FDA status for each investigational new drug or device. (See reverse side of this form.)

6/20/91 Date of IRB review and approval. (If approval is pending, write "pending." Followup certification is required.)
(month/day/year)

[X] Full Board Review [ ] Expedited Review

[ ] This activity contains multiple projects, some of which have not been reviewed. The IRB has granted approval on condition that all projects covered by 45 CFR 46 will be reviewed and approved before they are initiated and that appropriate further certification (Form HHS 596) will be submitted.

[ ] Human subjects are involved, but this activity qualifies for exemption under 46.101(b) in accordance with paragraph ______ (insert paragraph number of exemption in 46.101(b), 1 through 5), but the institution did not designate that exemption on the application.

6. Each official signing below certifies that the information provided on this form is correct and that each institution assumes responsibility for assuring required future reviews, approvals, and submissions of certification.

APPLICANT INSTITUTION	COOPERATING INSTITUTION
NAME, ADDRESS, AND TELEPHONE NO. Board of Trustees of Southern Illinois University Carbondale, Il 62901 217/782-3318	NAME, ADDRESS, AND TELEPHONE NO. Illinois Department of Public Health 525 West Jefferson Springfield, Il 62761 217/782-5830
NAME AND TITLE OF OFFICIAL (print or type) Richard C. Moy, Dean and Provost, for John C. Guyon, Ph.D., President, SIU	NAME AND TITLE OF OFFICIAL (print or type) John R. Lumpkin, M.D., Director 6/2[illegible]
SIGNATURE OF OFFICIAL LISTED ABOVE (and date) Richard H. Moy 6/26/91	SIGNATURE OF OFFICIAL LISTED ABOVE (and date) John R. Lumpkin 6/[illegible]/91

HHS 596 (Rev. 1/82)

(If additional space is needed, please use reverse side under "Notes.")

Southern Illinois University
School of Medicine
Springfield Committee
for Research Involving Human Subjects

Protocol #: _______
(to be assigned by Office of ADR)

Application for Approval of a Research Protocol

Instructions to Principal Investigators: Complete either A, B, or C as appropriate to your protocol. Please call the Office of the Associate Dean for Research, 782-7936, if you have questions.
Please Submit: One (1) copy of this application form along with the appropriate number of copies of other materials as indicated below to the Office of the Associate Dean for Research, 801 North Rutledge, Springfield, Illinois.

I. **Investigator:** Thomas F. Long

Department: Illinois Department of Public Health **Telephone:** (217) 782-5830

Co-Investigator(s): Catherine Copley

Title of Protocol: Multisite Heavy Metal Exposure Study in Illinois, Kansas and Missouri

Funding: ___ Departmental ___ CRC _X_ External (Specify) Agency for Toxic Substances and Disease Registry

Approval of Department Chair Indicated by Signature: [signature], M.D., M.P.H., Assistant Director, Office of Health Protection, IDPH

Other Department Involved: ___ Yes _X_ No

If Yes, Approval of Department Chair Indicated by Signature: ______

This Protocol will be implemented at:

___ Memorial Medical Center

___ St. John's Hospital

_x_ Neither

A. **Research presenting risk to subjects:** e.g. drug and medical device trials, surgical and other invasive procedures, studies involving randomization, placebo controls, etc.

Please Submit:
1. Thirty (30) copies of the complete protocol;
2. Thirty (30) copies of a consent form prepared on Form SCRIHS-B 12/82.

B. **Research presenting minimal risk to subjects:** In order for your study to be categorized as a "MINIMAL RISK" project, it must fall into one or more of the following areas. Please indicate the category:

___ 1. Collection of hair and nail clippings in a nondisfiguring manner; deciduous teeth; and permanent teeth if patient care indicates a need for extraction.

financial standing or employability; and (iii) the research deals with sensitive aspects of the subject's own behavior, such as illegal conduct, drug use, sexual behavior, or use of alcohol.

____ 4. Research involving the observation (including observation by participants) of public behavior, except where all of the following conditions exist: (i) observations are recorded in such a manner that the human subjects can be identified, directly or through identifiers linked to the subjects; (ii) the observations recorded about the individual, if they became known outside the research, could reasonably place the subject at risk of criminal or civil liability or be damaging to the subject's financial standing or employability; and (iii) the research deals with sensitive aspects of the subject's own behavior such as illegal conduct, drug use, sexual behavior, or use of alcohol.

____ 5. Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Please submit

1. Three (3) copies of the protocol.

II. All investigators must sign the following statement of assurance:

The proposed investigation involves the use of human subjects. I am submitting this form with a description of my protocol prepared in accordance with institutional policy for the protection of human subjects participating in research. I am responsible for:

- **insuring that informed consent is documented by the use of a written consent form approved by the IRB and signed by the subject or the subject's legally authorized representative and that each person signing the form is given a copy;**
- **placing the consent documents signed by human research subjects in a repository approved by the Associate Dean for Research;**
- **reporting the progress of the research to the Associate Dean for Research as often as and in the manner prescribed by SCRIHS but no less than once per year;**
- **reporting promptly through my department head to the Associate Dean for Research any injuries to human subjects or any unanticipated problems which involve risks to the human research subjects or others;**
- **reporting promptly through my department head to the Associate Dean for Research proposed changes in my research activity. I understand that changes in research during the period for which SCRIHS approval has already been given, shall not be initiated by me without SCRIHS review and approval, except where necessary to eliminate apparent immediate hazards to the subject;**
- **reporting promptly to the Associate Dean for Research and SCRIHS any serious or continuing noncompliance with the requirements of the SCRIHS General Assurance or the determinations of SCRIHS.**

Thomas F. Cong   4/26/91

Signature of Principal Investigator   **Date**

Note: Please refer to Southern Illinois University School of Medicine, Springfield Committee for Research Involving Human Subjects Assurance of Compliance with HHS Regulations for Protection of Human Research Subjects for policy regarding research involving human subjects.

SCRIHS

August 1991 6/20/91 Protocol # 91-37

Date

INFORMED CONSENT FORM

Informed consent consists of the following elements:

-A fair explanation in terms the subject can understand, of the procedures to be followed and their purposes including an identification of those which are experimental and a statement of the expected duration of the subject's participation;

-A description of any reasonably foreseeable discomforts or risks:

-A description of any benefits reasonably to be expected;

-A disclosure of any appropriate alternative procedures that might be advantageous for the subject;

-A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained. If the protocol is a FDA study, a statement should be added to the standard paragraph on confidentiality that the subject understands his or her identity will be revealed to the FDA;

-An explanation of compensation for injuries incurred in research;

-A offer to answer any inquiries concerning procedures;

-An instruction that the subject is free to withdraw his/her consent and to discontinue participation in the project or activity at any time without prejudice to the subject;

-No language through which the subject is made to waive or to appear to waive any of his/her legal rights or to release the institution or its agents from liability or negligence.

The following additional elements may be required depending on the nature of the protocol:

-A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable;

-Anticipated circumstances under which the subject's participation may be terminated by the research investigator without regard to the subject's consent;

-Any additional costs to the subject that may result from participation in the research;

-The consequences of a subject's decision to withdraw from the research and procedures for orderly termination of participation by the subject;

-A statement that significant new findings developed during the course of the research which may relate to the subject's willingness to continue participation will be provided to the subject; and

The approximate number of subjects involved in the study.

Individuals responsible for this research protocol:

Fred Stallings
Sara Sarasuwa
Agency for Toxic Substances and Disease Registry
Executive Park
Atlanta, Georgia
(404) 639-0564

Thomas Long
Catherine Copley
Illinois Department of Public Health
Division of Environmental Health
525 West Jefferson
Springfield, IL 62761
(217) 782-5830

Title of protocol: Multisite Heavy Metal Exposure Study in Illinois, Kansas, and Missouri

Expected duration of patient involvement in study: It may take approximately a total of two hours to review this consent form, answer questions about activities in and around the home, take my (child's/ward's) blood pressure, collect the urine sample, and draw the blood sample. It may take approximately three hours for researchers to do the necessary environmental work which may include collection of soil, water, and dust samples as well as a paint survey of the home.

I (My child/ward) agree(s) to participate as a subject in this research project, the main purpose of which is: To determine levels of heavy metals in blood and urine in people living in the study area to compare to those levels found in people living outside the study area as well as to currently accepted health guidelines; to determine any relationship between heavy metal levels found in blood and urine and those levels in environmental samples (soil, dust, paint, and water); to determine if those circumstances which may present greater risks of exposure to heavy metals; and to determine if measurements of some blood components can be identified that may indicate heavy metal exposures.

Description of research protocol (to include objectives, purposes, selection of patients, procedures to be followed, treatment plan, etc.): The Illinois Department of Public Health (IDPH) with assistance for the Agency for Toxic Substances and Disease Registry of the U.S. Public Health Service, is conducting an exposure study of heavy metal contamination in residential areas surrounding the N L Industries/Taracorp National Priority List (NPL) site in Granite City, Illinois. The goals of the study are as follows:

1. To compare my (child'/ward's) heavy metal levels in blood and urine to those found in people living in other areas.

2. To compare the amount of heavy metals in my environment with those found in other areas.

3. To analyze some of my blood components and see how they compare with those found in people living in other areas.

4. To compare the results of the tests of blood mentioned above with the standard reference ranges for these tests.

5. To determine if there is a statistical relationship between activities and/or situations in and around the home and the amount of heavy metals found in my (child's/ward's) body.

6. To compare the levels of heavy metals found in my (child's/ward/s) blood and the levels of blood components.

7. To compare the results of my community's exposure with people living in areas contaminated by both industrial and mining emissions.

As a resident, I am being asked to participate in order to determine the degree of my (child's/ward's) exposure to heavy metals. This study will include some people living within two miles of the NPL site. The individuals doing this study would like to include all children between the ages of 6 months through 71 months. Some older children and adults, chosen randomly, like tossing a coin, will be asked to participate. My (child's/ward's) part in the study may include:

1. Answering questions about habits and activities in and around the home and about the occupations of adults in the home. Questions concerning financial status will be asked as well. This interview will require about one hour.

2. Having blood pressure measured.

3. Permitting a blood sample not to exceed 30 milliliters (about 2 tablespoons) to be taken with a sterile needle from a vein in the arm. I (My child/ward) may be asked to provide a second sample at a future date to measure changes over time.

4. Providing a urine sample by voiding into a container. A container and instructions will be given to me. The sample may be picked up later. No urine is to be collected from infants.

5. Allowing testing on blood and urine samples for heavy metals and associated biological measurements. Some of the blood work for immunological tests is considered experimental.

6. Allowing environmental samples to be collected from in and around the home. This will require IDPH or their representatives to enter the home and conduct a survey of paint. In addition, water, dust, and soil samples may be collected to be analyzed for heavy metals. The sample collection may require up to three hours.

I understand that of the procedures described above, the following are experimental procedures: None.

I understand that the reasonable foreseeable risks or discomforts may be as follows: There is little risk associated with the blood drawing procedure. The needle will be left in my (child's/ward's) arm for a few minutes. I (My child/ward) can expect to experience some pain at the moment the needle goes into the arm. In about 10 percent of cases, a small amount of bleeding under the skin will produce a bruise (hematoma). There is a very small risk of temporary clotting of the vein, infection, or fainting.

I understand that the benefits which may reasonably be expected from my (my child's ward's) participation in this study are: I will know what kind of environment I live in and if I have been exposed to lead. A copy of this consent form will be given to me. Results of blood, urine, and immediate environment tests will be provided ~~to me~~ and/or our physician at no charge. I will be provided with recommendations to reduce the amount of exposure to heavy metals if results reflect potential of excessive heavy metal exposure. We will be included on a mailing list and will receive a copy of the final report.

I am aware that the following alternative procedures could be advantageous to me: Getting the same tests done by a private company or laboratory. I could choose to do nothing.